EXHIBIT 2

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

In re Flint Water Cases	Civil Action No. 5:16-cv-10444-JEL-MKM (consolidated) Hon. Judith E. Levy Mag. Mona K. Majzoub
Elnora Carthan, et al. v. Governor Rick Snyder, et al.	

DECLARATION OF HOWARD HU, M.D., M.P.H., Sc.D.

I, Howard Hu, M.D., M.P.H., Sc.D., state and declare as follows:

I. INTRODUCTION

1. My name is Howard Hu. I am a resident of Altadena, California. I am providing this Declaration at the request of counsel. I am legally competent to provide this Declaration.

2. I have been retained as a public health, epidemiology and medical expert on behalf of an issue class of persons in the City of Flint. who were exposed to Flint water during an event often referred to as the "Flint Water Crisis". I have been asked to address the following question: "Were the corrosive water conditions allegedly caused by Defendants capable of causing harm to Flint residents?", wherein "Exposure" is defined to include ingestion (either through drinking or consuming foods prepared with the drinking water), bodily contact with the water (such as by way of bathing), and property contact with the water (through residential plumbing or other appliances); and "Persons"

is defined to include only those individuals who have reached the age of majority (18 y.o.) as of the date of the class notice (August 17, 2022).[1]

3. I note that given the circumstances surrounding the Flint Water Crisis, I will be focusing my response to the question on the potential harm to Flint residents associated with exposure to the toxic metal lead as a result of ingesting Flint water for some duration between May 1, 2014 and October 16, 2015.[2]

II. QUALIFICATIONS/EXPERIENCE

4. I am a physician-scientist, internist and preventive medicine specialist, with a doctoral degree in epidemiology. As my *Curriculum Vitae* (attached as Exhibit 1) reflects, my current academic appointments are as the Flora L. Thornton Professor (tenured) of Preventive Medicine and Chair of the Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California. I am also Affiliate Professor in the University of Washington and Adjunct Professor in the University of Michigan. Previously, I had been the Founding Dean of the Dalla Lana School of Public Health and Professor of Environmental Health, Epidemiology, Global Health, and Medicine (tenured), University of Toronto (2012-2017); the National Sanitation Foundation (NSF) International Endowed Chair of the Department of Environmental Health Sciences, Professor of Environmental Health, Epidemiology and Medicine (tenured), Founding Director of the U.S. National Institute for Environmental

[1] The question posed by Issue #6 relates to a "Multi-Defendant Issues Class" (defined as persons who, for any period of time between February 10, 2015 and October 16, 2015, were exposed to or purchased drinking water supplied by the City of Flint), and to a "LAN Issues Subclass" (defined as persons who, for any period of time between April 25, 2014 and October 16, 2015, were exposed to or purchased drinking water supplied by the City of Flint)."

[2] Although the Class Period begins on April 25, 2014, I assume that the elevated levels of lead in water attributable to the water source switch to the Flint River do not begin until May 1, 2014. This issue is addressed in greater detail in the Declaration of Dr. Weisel.

Health Sciences (NIEHS) Environmental Health Core Sciences Center, and Associate Physician at the University of Michigan and University of Michigan Health System (2006-2012); and Professor of Occupational & Environmental Medicine (tenured), Founding Director of the NIEHS Center for Children's Environmental Health, Director of the Occupational Medicine Residency at the Harvard School of Public Health and Associate Physician in the Brigham & Women's Hospital in Boston (1988-2006).

5. I received my M.D. degree from the Albert Einstein College of Medicine in New York City in 1982, a Master of Public Health in Occupational Health from the Harvard School of Public Health in 1982, a Master of Science in Epidemiology from the Harvard School of Public Health in 1986, and a Doctorate of Science in Epidemiology from the Harvard School of Public Health in 1990. I am certified as a Diplomate by the American Board of Internal Medicine and as a Diplomate in Occupational Medicine by the American Board of Preventive Medicine. I was an Associate Professor of Medicine at the Harvard Medical School and a tenured Professor in the Department of Environmental Health at the Harvard School of Public Health until 2006 when I moved to Michigan to become Chair of the Department of Environmental Health Sciences and a tenured Professor at the University of Michigan School of Public Health. A more complete statement of my credentials is contained in my *curriculum vitae*, a copy of which is attached as Exhibit 1.

6. In terms of specific scientific expertise, since 1990, I have led multi-institutional and international teams of scientists, students and fellows devoted to investigating the environmental, nutritional, social, psychosocial, genetic and epigenetic determinants of chronic disease and impaired child development in population-based studies in the U.S.,

Mexico, India (where I was a senior faculty Fulbright Scholar, 2000-2001), China, and elsewhere around the world. Our research team's work has generated over 350 publications in the peer-reviewed literature and won several awards, such as the 1999 Progress and Achievement Award from the NIEHS, the 2009 Linus Pauling Lifetime Achievement Award, the 2011 Award of Excellence from the American Public Health Association, and the 2015 John Goldsmith Award for Outstanding Contributions from the International Society for Environmental Epidemiology. In my current position, I am continuing NIEHS-funded environmental birth cohort research, co-leading the Global Burden of Disease-Population Health initiative, which aims to improve understanding of pollution's "footprint" on the global burden of disease; and co-leading the USC COVID19 Pandemic Research Center and associated studies. In terms of service that capitalizes on my expertise, I served on, among other entities, the Board of Population and Public Health Practice of the Institute of Medicine of the National Academy of Sciences; on the Board of Environmental Studies and Toxicology of the National Research Council; on the External Advisory Council of NIEHS; and I am currently serving as the senior epidemiologist on the Energy Research Committee of the Health Effects Institute, and the Chair of the Scientific Advisory Board of the Marilyn Brachman Hoffman Foundation.

7. In terms of expertise and service specific to lead exposure and toxicity, I note that over 200 of my publications in the peer-reviewed literature have focused on investigations of lead exposure and resulting impacts on health, including research relevant to IQ, other aspects of cognition, behavior, educational attainment, physical growth, blood pressure, cardiovascular impacts, and renal function. For the last 20+

years, I have authored the Chapter on "Heavy Metals" for each edition (including the most recent 2022 edition) of Harrison's Principles of Internal Medicine, one of the most-widely read and authoritative textbooks in the world. As a clinician, I have also been the primary consultant in occupational/environmental medicine for over 100 cases of suspected lead toxicity and have served as the Grand Rounds discussant or lecturer on the subject of lead toxicity in leading universities around the world.

8. I have served on various scientific expert panels relating to lead for various state and federal agencies. For example, I was a member of the Ad Hoc Expert Panel to Form Medical Management Guidelines for Lead-exposed Adults for the National Institute of Occupational Safety and Health. I was a member of the Working Group on Lead and Pregnancy for the United States Centers for Disease Control. I served on the Scientific Advisory Board for the Massachusetts Division of Occupational Hygiene in connection with its lead registry project. I have served as an expert peer reviewer of U.S. government reports related to lead, such as the 2007 as well as the most recent 2020 edition of the *Toxicological Profile of Lead* produced by the Agency for Toxic Substances and Disease Registry of the U.S. Centers for Disease Control and Prevention, and the U.S. Environmental Protection Agency's (EPA) National Center for Environmental Economics Office of Policy's draft report on *Concentration-Response Functions between Lead Exposure and Adverse Health Outcomes for Use in Benefits Analysis: Cardiovascular-Disease Related Mortality*. I have also received competitively-awarded grants from various federal agencies relating to my work on the health effects of lead, including grants from the NIEHS for my work on measuring lead burden and childhood lead, grants from the NIEHS on the metabolic effects of pregnancy and lactation on lead

burden, a grant from the National Institute of Occupational Safety and Health in connection with the Carpenters' Lead Project, a grant from the Office of Research on Women's Health of the U.S. National Institutes of Health (NIH) relating to lead and hypertension in women, among other grants. In total, I've received peer-reviewed, competitively-awarded grants in excess of $25 million for research projects directly related to the health effects of lead from NIEHS and/or NIH. I have taught and continue to teach and give lectures on health effects of lead exposure.

9. As noted earlier, the question that I have been asked to address is: "Were the corrosive water conditions allegedly caused by Defendants capable of causing harm to Flint residents?", wherein "Exposure" is defined to include ingestion (either through drinking or consuming foods prepared with the drinking water), bodily contact with the water (such as by way of bathing), and property contact with the water (through residential plumbing or other appliances); and "Persons" is defined to include only those individuals who have reached the age of majority (18 yo) as of the date of the class notice (August 17, 2022). I approach this question from the perspective of the contamination of the water with the toxic metal lead, the major exposure of concern that has been widely appreciated with respect to the Flint water crisis.

10. The principles and methodology I employed in forming my response to the question are based on a review of and utilization of insights gained from peer-reviewed scientific literature that are relevant to the task at hand; the interpretation and utilization of publicly available data and data obtained in the discovery process that are relevant to the task at hand; and the reliance on the expert declarations of colleagues (Dr. Larry Russell, Dr. Clifford Weisel, and Dr. Panos Georgopoulos), involved in this matter who

have undertaken rigorous assessments related to exposure to lead from the Flint Water Crisis.

11. It is standard generally-accepted methodology for physicians, epidemiologists and toxicologists to rely on exposure assessments prepared by other scientists who specialize in providing such assessments. Exposure assessments may be based on testing results, but in the absence of such results, it is a scientifically valid and generally accepted methodology to estimate and/or model exposure levels based on relevant environmental data, which in this case, included (but was not limited to) the extensive data available regarding water lead levels, the presence of lead service lines, galvanized interior pipes, and lead-soldered copper plumbing, and other factors in Flint. It is also a scientifically valid and generally accepted methodology to model blood lead levels for individuals based on water lead levels, selected individual characteristics (such as age, sex, etc.) and the known pharmacokinetics of lead absorption, uptake, distribution, storage and elimination in humans. In providing my conclusions in this declaration, I have considered the materials referenced herein, as well as the expert declarations of Dr. Larry Russell, Dr. Clifford Weisel, and Dr. Panos Georgopoulos.

II. STATEMENT OF OPINION(S) AND FACTS OR DATA CONSIDERED

12. My opinions, and their scientific bases, are contained throughout this declaration. Each of my opinions are given with a reasonable degree of scientific certainty based upon a preponderance of the evidence. Summarized here are some of the most relevant considerations and opinions for purposes of presenting my analysis:

- My opinion is predicated upon the work presented in the declarations of Drs. Russell, Weisel, and Georgopoulos, which collectively present an integrated

process of assessment of exposures (in terms of lead levels in water) and associated doses to humans (in terms of elevations in blood lead levels). As set forth in those declarations, there are scientifically valid approaches towards using the data that are available to determine, with a reasonable degree of precision and accuracy, the likely range of exposures to lead in water among individuals who lived in Flint during the Flint Water Crisis and are currently adults; and, in turn, their likely impacts on blood lead levels.

- First, I note that the definition of "persons" (those individuals who have reached the age of majority (18 yo) as of the date of the class notice, i.e., August 17, 2022) as well as the known date when the Flint Water Crisis began (April 25, 2014).
- It is important to acknowledge that depending on the magnitude and duration of exposure, lead is capable of causing a wide range of adverse health impacts.
- For adults who were male and non-pregnant adult females (18 years old and older) during the Flint Water Crisis, the scientific literature supports the view that relatively modest elevations in blood lead levels – i.e., within 5 ug/dL, which is well within the range of values set forth by the exposure assessment conducted by Drs. Russell, Weisel and Georgopoulos--- are a cause of clinically-significant elevations in blood pressure as well the risk of clinical hypertension, which, in turn, pose elevated risks of adverse cardiovascular outcomes (e.g., myocardial infarction, stroke). These risks are generally greater with greater elevations in lead exposure.
- The scientific literature also supports the view that relatively modest elevations in blood lead levels (i.e., within 5 or 10 ug/dL) are a cause of adverse effects on

neurological, renal, hematological, immunological, and reproductive functions. A summary and detailed descriptions of these effects and their scientific basis is provided in the most recent version of the *Toxicological Profile for Lead* that was published in August of 2020 by the Agency for Toxic Substances and Disease Registry (ATSDR) of the U.S. Centers for Disease Control and Prevention[3]—a document for which I served as one of three expert peer reviewers.

- The scientific literature also provides some evidence to indicate that relatively modest elevations in blood lead levels are prospectively associated with increased risk of cardiovascular mortality in the general population *independent of its impact on blood pressure or hypertension*; however, in my opinion, the evidence base for this particular lead-outcome relationship is not sufficient for me to come to a conclusion regarding causality, in part, because of the lack of epidemiological evidence that can disentangle the independent impacts of lead on cardiovascular mortality from the impacts of lead on blood pressure or hypertension; and in part because it is unclear whether these risks relate to blood lead levels as a biomarker of on-going current exposure v. cumulative past exposure (that had typically accumulated over the course of many years).
- For adults who were female and pregnant during the Flint Water Crisis, the scientific literature supports the view that elevations in blood lead levels more likely than not adversely affected the cognitive development of their offspring.
- For those who are currently adults but were children during the Flint Water Crisis (i.e., 11 to 16 years old), the scientific literature supports the view that elevations

[3] ATSDR. *Toxicological Profile for Lead*. August, 2020. Atlanta: Agency for Toxic Substances and Disease Registry, U.S. Centers for Disease Control and Prevention. U.S. Department of Health Services.

in blood lead levels more likely than not adversely affected their cognitive development.

13. In terms of the methodology used to render my opinions, I note that understanding the extent to which exposure to lead associated with the Flint Water Crisis was "capable of causing harm to Flint residents" is dependent first on determining the extent to which exposure may have occurred and how such exposures may have resulted in "doses" of lead that were internalized by Flint residents and thereby capable of causing harm to internal organs. As such, the key metrics involved are measurements of lead levels in water (the "exposures", typically represented as micrograms/liter [µg/L] and the resulting lead levels in blood (the "doses", typically represented as micrograms/deciliter [µg/dL]. As such, determining the extent to which the exposure to lead associated with the Flint Water Crisis was capable of causing harm *and the types of harm caused* is largely dependent on determining the levels of lead in water that likely occurred as a result of the Flint Water Crisis and the resulting levels of lead in blood among Flint residents.

14. It needs to be acknowledged that the process of making the determination noted above presents several major challenges. One challenge is that "exposure" to water lead levels at residential taps during and following the Flint Water Crisis can be expected to vary spatially (i.e. across locations within the city depending on the condition and type of service line, connectors, and indoor plumbing at each location an individual consumes tap water or item prepared with tap water); temporally (i.e. over time - the course of a day, week, and month, because of flushing, water flow, local pipe and interior plumbing conditions); and frequency of an individual's consumption of the tap water. Another challenge is that even if an individual's level of exposure to tap water is known, that

individual's internalized "dose" of lead, i.e., amount of lead that would be absorbed from the gastrointestinal tract into blood that, in turn, would serve as the dose of lead to target organs such as the brain, can be expected to vary based on that individual's nutritional status (e.g., low dietary iron or calcium, or fasting, can increase the amount of lead absorbed from the gastrointestinal tract) as well as biological factors (e.g., an individual's age [infants absorb more lead from the gastrointestinal tract than adults], genetics, etc). This latter challenge can be addressed by taking direct measurements of lead in blood ("blood lead levels") at different intervals. However, a blood lead level by itself cannot inform whether the lead came from absorption of lead from tap water vs. lead that had come from other sources (e.g., soil, paint, internal stores of lead in bone). Thus, to address the above questions in an ideal world, data would be available that could pinpoint, for each plaintiff, the exposures and resulting internal doses of lead that were a result of the Flint Water Crisis (such as, for each plaintiff, repeated measures of lead in each plaintiff's tap water and venous blood taken before, during, and after the crisis, in conjunction with documentation on frequency of tap water consumption). This would provide data with which one could directly estimate an individual's exposure to lead in tap water and the influence of the lead so ingested on the individual's blood lead levels. By contrast, the exposure data that actually exist that are specific to individual plaintiffs are fragmentary, and in terms of time sequence, sporadic or only occurring at one point in time, and the internal dose data that actually exist that are specific to individual plaintiffs (i.e., blood lead levels) were not taken for most plaintiffs during time periods relevant to the Flint water crisis, or where available, are also sporadic or only occurring at one point

in time.[4] Nevertheless, as described in: 1) peer-reviewed academic literature which reviews lead exposure for Flint children in detail, and 2) the Exposure Assessment Analysis presented contemporaneously with this Declaration, there is no doubt that significant lead exposure occurred on a city-wide scale, given what is known about the changes in the Flint water supply, the resulting changes to the water chemistry, and the data (and analyses of that data) that are available.

15. In conjunction with the declarations of Drs. Weisel and Georgopoulos, this declaration first describes a process of "assessment of exposures and associated doses to individuals" to meet the task at hand. It utilizes a scientifically valid approach to conducting an exposure reconstruction based on available information to determine the range of likely water lead levels encountered by Flint residents during the Flint Water Crisis and what can be expected in terms of the likely resulting elevations in blood lead levels in Flint residents who are now adults.

16. The task inherently requires a trans-disciplinary approach that integrates principles and methods related to water quality, chemistry, materials science; civil/environment engineering, exposure science, biological dosimetry, toxicokinetics, environmental epidemiology, and general environmental health. Accordingly, what follows is the product of a trans-disciplinary team composed of experts who collectively provide overlapping expertise in each of the disciplines stated above (i.e., Dr. Larry Russell, Dr. Clifford Weisel, Dr. Panos Georgopoulos, and myself).

[4] The paucity of data as it relates to the exposure of children to lead in water during the Flint Water Crisis may be at least partially explained by the actions of the Defendants, who, according to the Plaintiffs' Complaint, provided assurances to the community of Flint that the water was safe to drink.

a. First, I rely on input from Dr. Clifford Weisel to describe the range of water lead levels that have been experienced among Flint residents during the Flint water crisis, and to select various levels of tap water lead across this range as exemplars of exposure scenarios.

b. Next, to extrapolate the likely blood lead levels that would result in relation to these different exposure scenarios of levels of lead contamination in tap water, I rely on the application by Dr. Panos Georgopoulos of a model (the "AALM-Leggett model") proposed for individuals who were 10 to 65 years in 2014, since they span an age range that are currently adults (18 to 73 years old) (see declaration by Dr. Panos Georgopoulos). These extrapolations include the likely "baseline blood lead levels", i.e., the blood lead levels for individuals of different age groups that would result if the water lead level is below the detectable limit (i.e., indistinguishable from 0). It is noted here that the associated blood lead levels are not necessarily 0, since there are also assumed levels of exposure from other sources, such as dust and soil. The estimated "baseline blood lead level" can then be subtracted from the estimated blood lead levels associated with a given tap water lead level to calculate the estimated blood lead level specific for the contribution of the Flint water crisis, i.e., the "Flint water crisis-associated elevation in blood lead level".

c. Finally, for the estimated range of blood lead levels provided by Dr. Georgopoulos, I discuss the potential harms, as requested.

17. In Table 1, Dr. Panos Georgopoulos has provided a matrix of water lead levels

UPDATED WORKING DRAFT - DO NOT CITE OR QUOTE

BLL estimates (µg/dL) from AALM-Leggett model for 90 days exposure of female and male subjects 10-65 years old for representative WLLs (µg/L)

			BLL (µg/dL)														
			Age (years) - Female Subjects														
	WLL (µg/L)	WLL increase (µg/L) over pre-crisis level	10	12	14	16	18	20	25	30	35	40	45	50	55	60	65
Pre-Crisis Levels	1.00		1.26	1.07	1.00	1.14	1.44	1.73	2.27	2.32	2.34	2.38	2.43	2.49	2.50	2.51	2.52
	2.00	*1.00*	1.28	1.08	1.01	0.15	1.46	1.75	2.31	2.36	2.38	2.43	2.48	2.53	2.55	2.56	2.56
	3.00	*2.00*	1.29	1.10	1.03	1.17	1.48	1.77	2.35	2.41	2.43	2.47	2.52	2.58	2.59	2.60	2.60
	5.00	*4.00*	1.33	1.12	1.05	1.19	1.51	1.82	2.42	2.49	2.51	2.56	2.62	2.68	2.69	2.68	2.67
	10.00	*9.00*	1.41	1.19	1.11	1.26	1.59	1.92	2.61	2.69	2.73	2.79	2.85	2.92	2.91	2.90	2.87
	20.00	*19.00*	1.58	1.32	1.23	1.39	1.76	2.14	2.99	3.11	3.17	3.25	3.33	3.40	3.37	3.32	3.25
	50.00	*49.00*	2.08	1.73	1.59	1.79	2.27	2.78	4.14	4.34	4.47	4.62	4.74	4.85	4.74	4.60	4.41
	100.00	*99.00*	2.92	2.40	2.19	2.45	3.11	3.86	6.05	6.40	6.65	6.90	7.10	7.26	7.02	6.72	6.34
	200.00	*199.00*	4.60	3.74	3.39	3.77	4.78	6.00	9.73	10.31	10.75	11.12	11.50	11.75	11.33	10.81	10.11
	300.00	*299.00*	6.28	5.08	4.60	5.09	6.46	8.15	12.97	13.75	14.37	14.94	15.41	15.79	15.23	14.52	13.59

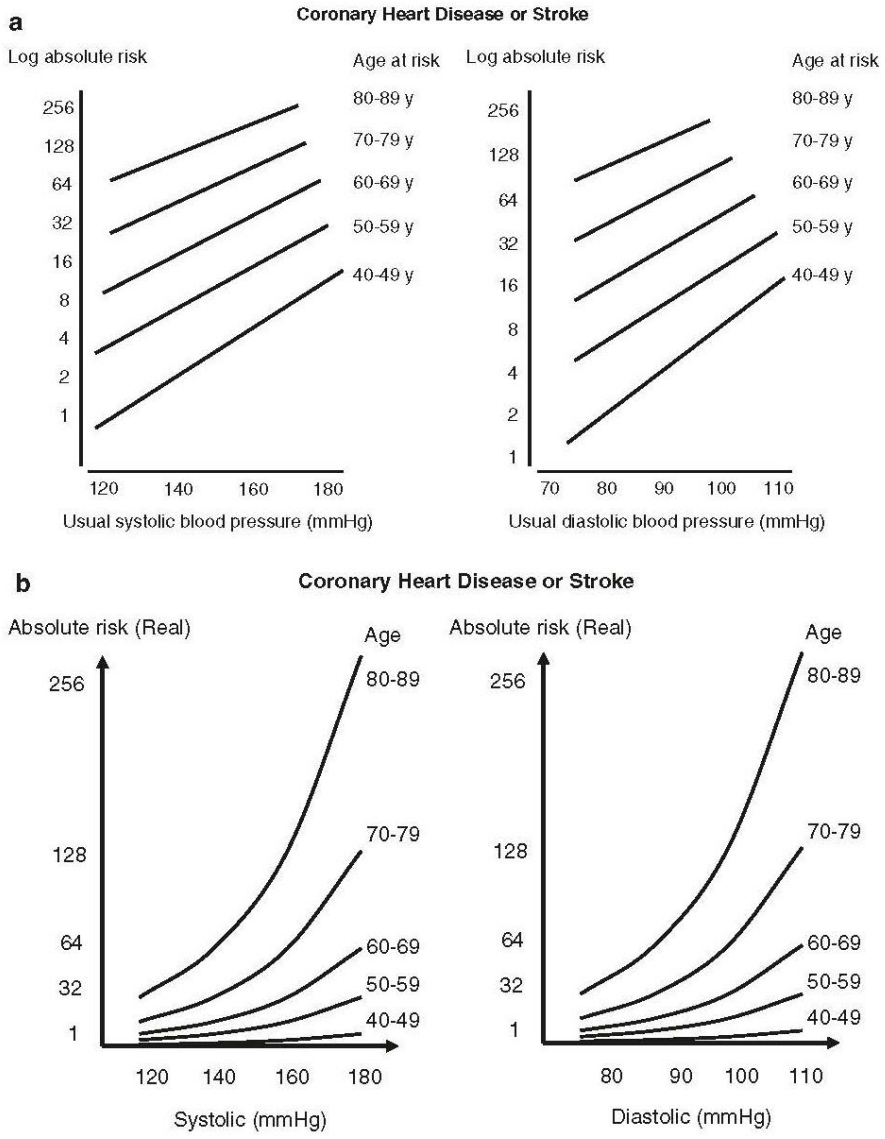
			Age (years) - Male Subjects														
			10	12	14	16	18	20	25	30	35	40	45	50	55	60	65
Pre-Crisis Levels	1.00		1.38	1.18	1.01	1.03	1.21	1.40	1.80	1.84	1.85	1.88	1.92	1.97	1.98	1.99	2.00
	2.00	*1.00*	1.40	1.20	1.02	1.04	1.22	1.42	1.83	1.87	1.89	1.92	1.96	2.01	2.02	2.03	2.03
	3.00	*2.00*	1.42	1.21	1.03	1.05	1.24	1.43	1.86	1.91	1.92	1.96	2.00	2.05	2.06	2.06	2.06
	5.00	*4.00*	1.46	1.24	1.06	1.08	1.27	1.47	1.92	1.97	2.00	2.04	2.08	2.13	2.14	2.13	2.13
	10.00	*9.00*	1.55	1.32	1.12	1.14	1.34	1.56	2.08	2.15	2.18	2.23	2.28	2.33	2.33	2.31	2.29
	20.00	*19.00*	1.73	1.47	1.25	1.26	1.49	1.75	2.40	2.49	2.55	2.61	2.68	2.74	2.71	2.67	2.61
	50.00	*49.00*	2.29	1.93	1.63	1.64	1.93	2.30	3.37	3.53	3.64	3.76	3.87	3.96	3.87	3.75	3.59
	100.00	*99.00*	3.21	2.69	2.26	2.27	2.67	3.21	4.97	5.26	5.47	5.68	5.86	5.99	5.79	5.54	5.22
	200.00	*199.00*	5.05	4.22	3.53	3.52	4.15	5.05	8.18	8.71	9.14	9.51	9.81	10.02	9.63	9.12	8.47
	300.00	*299.00*	6.89	5.74	4.79	4.77	5.64	6.88	11.20	11.89	12.45	12.96	13.37	13.67	13.16	12.49	11.61

and associated blood lead levels. The water lead levels span the levels of lead observed in Flint water during the Flint water crisis, with references citing the sources of the data (see declaration by Dr. Georgopoulos). The blood lead levels were calculated by Dr. Georgopoulos based on the water lead levels and application of the AALM-Leggett model for individuals who were 10 to 65 years old in 2014 (now 18 to 73 years old). Elevations in blood lead that can be attributed specifically to elevations of lead in drinking water can be derived by taking the blood lead levels (BLLs) in any particular column and subtracting the BLL in the first row, i.e., the BLL associated with the assumed Pre-Crisis Water Lead Level of 1 ug/L. From that perspective, one can see for illustrative purposes that for a 10 year old female, the elevations in BLL associated with increases in water lead levels spanning 1 to

299 ug/L (column 2) can be expected to range from 1.28-1.26=0.02 ug/L to 6.28-1.26=5.02 ug/L. For a 50 year old female, the same increases in water lead levels (1-299 ug/L) can be expected to be associated with elevations in BLL ranging from 2.53-2.49=0.04 ug/L to 15.79-2.49=13.3 ug/L. I note that it is possible that some Flint residents may have been exposed to water lead levels exceeding 300 ug/L, the maximum level in the Table Under such a scenario, the corresponding blood lead levels would be progressively higher. Similarly, I understand that durations longer than the 90 day duration modeled by Dr. Georgopoulos may similarly generate progressively higher blood lead levels.

18. Lead, blood pressure and hypertension As stated in my summary, regarding adults who were male and non-pregnant adult females (18 years old and older) during the Flint Water Crisis, the scientific literature supports the view that relatively modest elevations in blood lead levels -- in the range of values set forth above, i.e., below 10 ug/dL and even below 5 ug/dL--- are a cause of clinically-significant elevations in blood pressure, which, in turn, are

well-known to pose elevated risks of adverse cardiovascular outcomes (i.e., myocardial infarction, stroke). This is relevant to my discussion, as even modest elevations in blood pressure, including elevations in blood pressure among those who have not been diagnosed with hypertension, increase the risks of myocardial infarction (heart attacks)[5],[6] strokes, and other adverse cardiovascular events, a relationship illustrated in the accompanying figure[4]. This accounts for the progressively lower levels of blood pressure that have been considered by expert panels as cut-offs for distinguishing normal from elevated blood pressures. As of 2018, for example, the American College of



[5] Lewington S, Clarke R, Qizilbash N, Peto R, Collins R; Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002 Dec 14;360(9349):1903-13. doi: 10.1016/s0140-6736(02)11911-8. Erratum in: Lancet. 2003 Mar 22;361(9362):1060. PMID: 12493255.

[6] Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Hypertension. 2020 Feb;75(2):285-292. doi: 10.1161/HYPERTENSIONAHA.119.14240. Epub 2019 Dec 23. PMID: 31865786.

Cardiology and American Heart Association has stated that blood pressure is considered elevated if the systolic blood pressure is 120 or above[7].

In terms of the evidence base for lead's impact on blood pressure at relatively low levels of lead in blood, I first point to a systematic review of the relevant scientific literature that was conducted by Navas-Acien et al. and published in 2007 in *Environmental Health Perspectives,* the official journal of the U.S. National Institute for Environmental Health Sciences. The review concluded that the evidence is sufficient to infer a causal relationship of lead exposure with hypertension[8]. The conclusion was based both on the experimental evidence in animals as well as the epidemiological evidence, mostly of studies of community-exposed populations, and in consideration of each of the Bradford Hill criteria, e.g., consistency, temporality, strength of the association, dose-response, biologic plausibility. Since then, many more studies have confirmed in the U.S. as well as internationally that in samples of the general population at relatively low blood lead levels (BLLs; i.e., BLLs <5 µg/dL), lead is associated with increased blood pressure and/or risk of hypertension, such as Gambelunghe et al.[9] (2016; mean BLL: 2.8 µg/dL);

[7] Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD, Wright JT Jr. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Soc Hypertens. 2018 Aug;12(8):579.e1-579.e73. doi: 10.1016/j.jash.2018.06.010. PMID: 30219548.

[8] Navas-Acien A, Guallar E, Silbergeld EK, Rothenberg SJ. Lead exposure and cardiovascular disease--a systematic review. Environ Health Perspect. 2007 Mar;115(3):472-82. doi: 10.1289/ehp.9785. Epub 2006 Dec 22. PMID: 17431501; PMCID: PMC1849948.

[9] Gambelunghe A, Sallsten G, Borné Y, Forsgard N, Hedblad B, Nilsson P, Fagerberg B, Engström G, Barregard L. Low-level exposure to lead, blood pressure, and hypertension in a population-based cohort. Environ Res. 2016 Aug;149:157-163. doi: 10.1016/j.envres.2016.05.015. Epub 2016 May 18. PMID: 27208466.

Lee et al.[10] (2016; geometric mean BLL 1.8 µg/dL); de Almeida Lopes et al.[11] (2017; geometric mean BLL 1.97 µg/dL); Chen et al.[12] (2017; median BLL: 4.4 µg/dL); Teye et al.[13] (2020; mean BLL: 1.3-2.2 µg/dL); Tsoi et al.[14] (2021; mean BLL 0.92 to 1.75 µg/dL); and Yan et al.[15] (2022; geometric mean 4.7 µg/dL).

19. Relatively modest elevations in BLL (all under 5 µg/dL) have also been shown in U.S. general population data to be associated with uncontrolled hypertension defined as systolic blood pressure >130 Hg or diastolic blood pressure >80 mm Hg[16]. My own research group has also generated evidence indicating that chronic low level lead exposure increases the risk of hypertension that is resistant to treatment, defined as (1) inadequate systolic blood pressure (>140 mm Hg) or diastolic blood pressure (>90 mm Hg) while taking 3 medications; or (2) requiring >4 medications for blood pressure control[17]. In my opinion, these relationships are more likely than not causal.

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[10] Lee KR, Ko KD, Hwang IC, Suh HS, Kim KK. Association between blood lead levels and blood pressures in a non-smoking healthy Korean population. Postgrad Med J. 2017 Sep;93(1103):513-518. doi: 10.1136/postgradmedj-2016-134208. Epub 2016 Aug 23. PMID: 27555608.

[11] Almeida Lopes ACB, Silbergeld EK, Navas-Acien A, Zamoiski R, Martins ADC Jr, Camargo AEI, Urbano MR, Mesas AE, Paoliello MMB. Association between blood lead and blood pressure: a population-based study in Brazilian adults. Environ Health. 2017 Mar 14;16(1):27. doi: 10.1186/s12940-017-0233-5. PMID: 28292314; PMCID: PMC5351182.

[12] Chen C, Li Q, Nie X, Han B, Chen Y, Xia F, Zhai H, Wang N, Lu Y. Association of lead exposure with cardiovascular risk factors and diseases in Chinese adults. Environ Sci Pollut Res Int. 2017 Oct;24(28):22275-22283. doi: 10.1007/s11356-017-9884-6. Epub 2017 Aug 10. PMID: 28799038.

[13] Teye SO, Yanosky JD, Cuffee Y, Weng X, Luquis R, Farace E, Wang L. Association between blood lead levels and blood pressure in American adults: results from NHANES 1999-2016. Environ Sci Pollut Res Int. 2020 Dec;27(36):45836-45843. doi: 10.1007/s11356-020-10381-3. Epub 2020 Aug 16. PMID: 32803607.

[14] Tsoi MF, Lo CWH, Cheung TT, Cheung BMY. Blood lead level and risk of hypertension in the United States National Health and Nutrition Examination Survey 1999-2016. Sci Rep. 2021 Feb 4;11(1):3010. doi: 10.1038/s41598-021-82435-6. PMID: 33542319; PMCID: PMC7862639.

[15] Yan LD, Rouzier V, Pierre JL, Lee MH, Muntner P, Parsons PJ, Apollon A, St-Preux S, Malebranche R, Pierre G, Emmanuel E, Nash D, Kingery J, Walsh KF, Smith CE, Metz M, Tymejczyk O, Deschamps M, Pape JW, Fitzgerald DW, McNairy ML. High Lead Exposure Associated With Higher Blood Pressure in Haiti: a Warning Sign for Low-Income Countries. Hypertension. 2022 Jan;79(1):283-290. doi: 10.1161/HYPERTENSIONAHA.121.18250. Epub 2021 Nov 17. PMID: 34878898; PMCID: PMC8667279.

[16] Miao H, Liu Y, Tsai TC, Schwartz J, Ji JS. Association Between Blood Lead Level and Uncontrolled Hypertension in the US Population (NHANES 1999-2016). J Am Heart Assoc. 2020 Jul 7;9(13):e015533. doi: 10.1161/JAHA.119.015533. Epub 2020 Jun 23. PMID: 32573312; PMCID: PMC7670543.

[17] Zheutlin AR, Hu H, Weisskopf MG, Sparrow D, Vokonas PS, Park SK. Low-Level Cumulative

20. Here are common factors that have been found to worsen lead's impact on blood pressure and/or hypertension. For example, my research group found evidence that stress[18] (measured with validated questionnaire instruments), depression[19], and low socioeconomic status[20] amplify the impact of lead exposure on risk of hypertension. In my opinion, these interactions are more likely than not causal.

21. As noted earlier, the scientific literature also supports the view that relatively modest elevations in blood lead levels (i.e., below 5 ug/dL) can result in adverse effects on neurological, renal, hematological, immunological, and reproductive functions, as reflected in the Summary of Health Effects (Chapter 1.2) of the latest version of the Toxicological Profile for Lead that was published in August of 2020 by the Agency for Toxic Substances and Disease Registry (ATSDR) of the U.S. Centers for Disease Control and Prevention. I will discuss each of these outcomes in the following sections.

22. Lead exposure associated with relatively modest elevations in BLL (i.e., within 5 or 10 ug/dL) has been associated with worse neurological function in adults, in particular, cognitive abilities involving attention, memory and learning; altered neuromotor and

Lead and Resistant Hypertension: A Prospective Study of Men Participating in the Veterans Affairs Normative Aging Study. J Am Heart Assoc. 2018 Nov 6;7(21):e010014. doi: 0.1161/JAHA.118.010014. PubMed PMID: 30608198.

[18] Peters JL, Kubzansky L, McNeely E, Schwartz J, Spiro A 3rd, Sparrow D, Wright RO, Nie H, Hu H. Stress as a potential modifier of the impact of lead levels on blood pressure: the normative aging study. Environ Health Perspect. 2007 Aug;115(8):1154-9. doi: 10.1289/ehp.10002. PMID: 17687441; PMCID: PMC1940093.

[19] Hicken MT, Gee GC, Connell C, Snow RC, Morenoff J, Hu H. Black-white blood pressure disparities: depressive symptoms and differential vulnerability to blood lead. Environ Health Perspect. 2013 Feb;121(2):205-9. doi: 10.1289/ehp.1104517. Epub 2012 Oct 25. PMID: 23127977; PMCID: PMC3569674.

[20] Hicken MT, Gee GC, Morenoff J, Connell CM, Snow RC, Hu H. A novel look at racial health disparities: the interaction between social disadvantage and environmental health. Am J Public Health. 2012 Dec;102(12):2344-51. doi: 10.2105/AJPH.2012.300774. Epub 2012 Oct 18. PMID: 23078461; PMCID: PMC3519308.

neurosensory function; and altered mood and behavior[21],[22],[23],[24] both in men as well as women[25]. I consider each of these relationships to be more likely than not causal. (Note: lead exposure that is higher [i.e., with BLLs>30ug/dL] is associated with a variety of decrements in cognitive function, behavior and nerve function, including postural sway and stability; decreased walking speed; decreased visuospatial function and visual-motor performance; decrements in hearing; peripheral neuropathy; psychiatric symptoms [depression, panic disorders, anxiety, hostility, confusion, anger, and schizophrenia]; and lead exposure that is even higher [i.e., with BLLs >80 ug/dL] carry the risk of causing seizures, coma, and death).

23. Lead exposure associated with relatively modest elevations in BLL (i.e., within 5 or 10 ug/dL) has also been associated with worse kidney function (in terms of glomerular filtration). (Note: lead exposure that is high [i.e., with BLLs > 30 ug/dL] and sustained can cause kidney toxicity in the form of proximal tubular nephropathy, glomerular sclerosis, interstitial fibrosis, and tubular necrosis). This has been demonstrated in both

[21] Przybyla J, Houseman EA, Smit E, Kile ML. A path analysis of multiple neurotoxic chemicals and cognitive functioning in older US adults (NHANES 1999-2002). Environ Health. 2017 Mar 7;16(1):19. doi: 10.1186/s12940-017-0227-3. PMID: 28270159; PMCID: PMC5341442.

[22] Farooqui Z, Bakulski KM, Power MC, Weisskopf MG, Sparrow D, Spiro A 3rd, Vokonas PS, Nie LH, Hu H, Park SK. Associations of cumulative Pb exposure and longitudinal changes in Mini-Mental Status Exam scores, global cognition and domains of cognition: The VA Normative Aging Study. Environ Res. 2017 Jan;152:102-108. doi: 10.1016/j.envres.2016.10.007. PubMed PMID: 27770710; PubMed Central PMCID: PMC5135609.

[23] Bakulski KM, Seo YA, Hickman RC, Brandt D, Vadari HS, Hu H, Park SK. Heavy Metals Exposure and Alzheimer's Disease and Related Dementias. J Alzheimers Dis. 2020;76(4):1215-1242. doi: 10.3233/JAD-200282. PMID: 32651318; PMCID: PMC7454042.

[24] Rhodes D, Spiro A 3rd, Aro A, Hu H. Relationship of bone and blood lead levels to psychiatric symptoms: the normative aging study. J Occup Environ Med. 2003 Nov;45(11):1144-51. PubMed PMID: 14610395.

[25] Weuve J, Korrick SA, Weisskopf MA, Ryan L, Schwartz J, Nie H, Grodstein F, Hu H. Cumulative exposure to lead in relation to cognitive function in older women, Environ Health Perspec 2009 Apr;117(4):574-80. Epub 2008 Dec 11. PMID: 19440496. PMCID: PMC2679601

cross-sectional as well as longitudinal studies[26],[27], and in women[28] as well as men. The overall dose-effect pattern indicates an increasing severity of nephrotoxicity associated with increasing BLLs, with effects on glomerular filtration evident at BLLs <10 μg/dL, enzymuria and proteinuria becoming evident >10 μg/dL, and severe deficits in function and pathological changes occurring in association with BLLs >50 μg/dL. My research group has generated evidence demonstrating that the impact of lead on renal function is worse among those with type II diabetes[29] and those with the ALAD 1-2 and 2-2 genotype[30]. I consider each of these relationships to be more likely than not causal.

24. Lead exposure associated with elevations in BLL within 10 ug/dL has also been associated with adverse hematological effects in adults and children, i.e., in the form of decreased hemoglobin levels in blood. (Note: lead exposure that is high [i.e., with BLLs > 20 ug/dL] are associated with a risk of developing clinical anemia). I consider these relationships to be more likely than not causal.

25. Lead exposure associated with elevations in BLL within 10 ug/dL has also been associated with perturbations of the immune system in adults and children in the form of changes in humoral and cell-mediated immunity that can lead to autoimmunity and

[26] Kim R, Rotnitsky A, Sparrow D, Weiss S, Wager C, Hu H. A longitudinal study of low-level lead exposure and impairment of renal function. The Normative Aging Study. JAMA. 1996 Apr 17;275(15):1177-81. PMID: 8609685.
[27] Harari F, Sallsten G, Christensson A, Petkovic M, Hedblad B, Forsgard N, Melander O, Nilsson PM, Borné Y, Engström G, Barregard L. Blood Lead Levels and Decreased Kidney Function in a Population-Based Cohort. Am J Kidney Dis. 2018 Sep;72(3):381-389. doi: 10.1053/j.ajkd.2018.02.358. Epub 2018 Apr 23. PMID: 29699886.
[28] Pollack AZ, Mumford SL, Mendola P, Perkins NJ, Rotman Y, Wactawski-Wende J, Schisterman EF. Kidney biomarkers associated with blood lead, mercury, and cadmium in premenopausal women: a prospective cohort study. J Toxicol Environ Health A. 2015;78(2):119-31. doi: 10.1080/15287394.2014.944680. PMID: 25424620; PMCID: PMC4246415.
[29] Tsaih SW, Korrick S, Schwartz J, Amarasiriwardena C, Aro A, Sparrow D, Hu H. Lead, diabetes, hypertension, and renal function: the normative aging study. Environ Health Perspect. 2004 Aug;112(11):1178-82. PubMed PMID: 15289163; PubMed Central PMCID: PMC1247478.
[30] Wu MT, Kelsey K, Schwartz J, Sparrow D, Weiss S, Hu H. A delta-aminolevulinic acid dehydratase (ALAD) polymorphism may modify the relationship of low-level lead exposure to uricemia and renal function: the normative aging study. Environ Health Perspect. 2003 Mar;111(3):335-41. doi: 10.1289/ehp.5504. PMID: 12611663; PMCID: PMC1241391.

inflammation[31]. There also is evidence suggesting that BLL within 10 ug/dL increase susceptibility to infections[32],[33] as well as sensitization to allergens[34],[35]. I consider these relationships to be suggestive of causality based on the current science, but without enough evidence to be considered more likely than not causal at the current time.

26. There also is some research suggesting that relatively modest elevations in blood lead levels are prospectively associated with increased risk of cardiovascular mortality in the general population *independent of its impact on blood pressure or hypertension*[36]; however, in my opinion, the evidence base for this particular lead-outcome relationship is not sufficient for me to come to a conclusion regarding causality, in part, because of the lack of epidemiological that can disentangle the independent impacts of lead on cardiovascular from the impacts of lead on blood pressure or hypertension; and in part because it is unclear whether these risks relate to blood lead levels as a biomarker of on-going current exposure v. cumulative past exposure (that had typically accumulated over the course of many years).

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[31] Sirivarasai J, Wananukul W, Kaojarern S, Chanprasertyothin S, Thongmung N, Ratanachaiwong W, Sura T, Sritara P. Association between inflammatory marker, environmental lead exposure, and glutathione S-transferase gene. Biomed Res Int. 2013;2013:474963. doi: 10.1155/2013/474963. Epub 2013 Jan 17. PMID: 23484121; PMCID: PMC3581115.

[32] Park WJ, Kim SH, Kang W, Ahn JS, Cho S, Lim DY, Kim S, Moon JD. Blood lead level and Helicobacter pylori infection in a healthy population: A cross-sectional study. Arch Environ Occup Health. 2020;75(6):333-338. doi: 10.1080/19338244.2019.1654969. Epub 2019 Aug 20. PMID: 31429670.

[33] Krueger WS, Wade TJ. Elevated blood lead and cadmium levels associated with chronic infections among non-smokers in a cross-sectional analysis of NHANES data. Environ Health. 2016 Feb 11;15:16. doi: 10.1186/s12940-016-0113-4. PMID: 26864738; PMCID: PMC4750187.

[34] Pizent A, Macan J, Jurasović J, Varnai VM, Milković-Kraus S, Kanceljak-Macan B. Association of toxic and essential metals with atopy markers and ventilatory lung function in women and men. Sci Total Environ. 2008 Feb 15;390(2-3):369-76. doi: 10.1016/j.scitotenv.2007.10.049. Epub 2007 Nov 28. PMID: 18045657.

[35] Jedrychowski W, Perera F, Maugeri U, Miller RL, Rembiasz M, Flak E, Mroz E, Majewska R, Zembala M. Intrauterine exposure to lead may enhance sensitization to common inhalant allergens in early childhood: a prospective prebirth cohort study. Environ Res. 2011 Jan;111(1):119-24. doi: 10.1016/j.envres.2010.11.002. Epub 2010 Nov 20. PMID: 21094490; PMCID: PMC3026073.

[36] Lanphear BP, Rauch S, Auinger P, Allen RW, Hornung RW. Low-level lead exposure and mortality in US adults: a population-based cohort study. Lancet Public Health. 2018 Apr;3(4):e177-e184. doi: 10.1016/S2468-2667(18)30025-2. Epub 2018 Mar 12. PMID: 29544878.

27. For adults who were female and pregnant during the Flint Water Crisis, the scientific literature supports the view that elevations in blood lead levels adversely affect the cognitive development of their offspring[37]. This has been well documented by my research group[38] as well as in a preponderance of other prospective epidemiological studies[39],[40],[41]. I consider the relationship as being more likely than not causal. Among the mechanisms being identified for lead's prenatal effects is DNA methylation, an active area of investigation by my research group[42] and others.

28. For adults who were female and pregnant during the Flint Water Crisis, two studies[43], including one from my research group[44], have provided evidence that elevations in BLLs may result in increased blood pressure in the offspring when they

[37] Centers for Disease Control and Prevention (CDC). Work Group on Lead and Pregnancy (Hu:member). Ettinger AS and Wengrowitz AG, Editors. Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women. Atlanta: Centers for Disease Control. November, 2010. Available at: https://www.cdc.gov/nceh/lead/prevention/pregnant.htm ; accessed October 7, 2020

[38] Hu H, Téllez-Rojo MM, Bellinger D, Smith D, Ettinger AS, Lamadrid-Figueroa H, Schwartz J, Schnaas L, Mercado-García A, Hernández-Avila M. Fetal lead exposure at each stage of pregnancy as a predictor of infant mental development. Environ Health Perspect. 2006 Nov;114(11):1730-5. doi: 10.1289/ehp.9067. PMID: 17107860; PMCID: PMC1665421.

[39] Liu J, Gao D, Chen Y, Jing J, Hu Q, Chen Y. Lead exposure at each stage of pregnancy and neurobehavioral development of neonates. Neurotoxicology. 2014 Sep;44:1-7. doi: 10.1016/j.neuro.2014.03.003. Epub 2014 Apr 2. PMID: 24704588.

[40] Jedrychowski W, Perera F, Jankowski J, Mrozek-Budzyn D, Mroz E, Flak E, Edwards S, Skarupa A, Lisowska-Miszczyk I. Gender specific differences in neurodevelopmental effects of prenatal exposure to very low-lead levels: the prospective cohort study in three-year olds. Early Hum Dev. 2009 Aug;85(8):503-10. doi: 10.1016/j.earlhumdev.2009.04.006. Epub 2009 May 17. PMID: 19450938; PMCID: PMC3725459.

[41] Merced-Nieves FM, Chelonis J, Pantic I, Schnass L, Téllez-Rojo MM, Braun JM, Paule MG, Wright RJ, Wright RO, Curtin P. Sexually dimorphic associations between prenatal blood lead exposure and performance on a behavioral testing battery in children. Neurotoxicol Teratol. 2022 Mar-Apr;90:107075. doi: 10.1016/j.ntt.2022.107075. Epub 2022 Jan 31. PMID: 35108597; PMCID: PMC8957713.

[42] Rygiel CA, Dolinoy DC, Bakulski KM, Aung MT, Perng W, Jones TR, Solano-González M, Hu H, Tellez-Rojo MM, Schnaas L, Marcela E, Peterson KE, Goodrich JM. DNA methylation at birth potentially mediates the association between prenatal lead (Pb) exposure and infant neurodevelopmental outcomes. Environ Epigenet. 2021 Jun 16;7(1):dvab005. doi: 10.1093/eep/dvab005. PMID: 34141453; PMCID: PMC8206046.

[43] Gump BB, Stewart P, Reihman J, Lonky E, Darvill T, Matthews KA, Parsons PJ. Prenatal and early childhood blood lead levels and cardiovascular functioning in 9(1/2) year old children. Neurotoxicol Teratol. 2005 Jul-Aug;27(4):655-65. doi: 10.1016/j.ntt.2005.04.002. PMID: 15919179.

[44] Zhang A, Hu H, Sánchez BN, Ettinger AS, Park SK, Cantonwine D, Schnaas L, Wright RO, Lamadrid-Figueroa H, Tellez-Rojo MM. Association between Prenatal Lead Exposure and Blood Pressure in Female Offspring. Environ Health Perspect. 2012 Mar;120(3):445-50. doi: 10.1289/ehp.1103736. Epub 2011 Sep 21. PubMed PMID: 21947582; PubMed Central PMCID: PMC3295346.

become adolescents; however, this topic has not seen enough research to confirm this relationship as more likely than not causal.

29. For those who are currently adults but were children during the Flint Water Crisis (i.e., 11 to 16 years old), the scientific literature supports the view that elevations in BLLs more likely than not adversely affected their cognitive development in a manner similar to the well-known impacts of lead exposure on young children (i.e., those less than 7 years old). This is not based on epidemiological studies of adolescents in which the effect of lead exposure or increased lead exposure during adolescence could be separated from the effects of lead exposure prior to age 11, as no such research exists to my knowledge; rather, it is based on the likely mechanisms by which lead adversely affect neurodevelopment, which involve, among other things, interference with synaptogenesis[45],[46]; and the fact that although the brain may be done growing in size, it does not finish developing and maturing, with synaptogenesis being a key component, until the mid- to late 20s. In particular, the prefrontal cortex, the area of the brain responsible for skills like planning, prioritizing, and controlling impulses, is one of the last brain regions to mature.[47]

30. Finally, I note that for each of the lead exposure-health outcome relationships described above, the magnitude of the harm would more likely than not be expected to be

[45] Hu F, Xu L, Liu ZH, Ge MM, Ruan DY, Wang HL. Developmental lead exposure alters synaptogenesis through inhibiting canonical Wnt pathway in vivo and in vitro. PLoS One. 2014 Jul 7;9(7):e101894. doi: 10.1371/journal.pone.0101894. PMID: 24999626; PMCID: PMC4084981.
[46] Neuwirth LS, Volpe NP, Corwin C, Ng S, Madan N, Ferraro AM, Furman Y, El Idrissi A. Taurine Recovery of Learning Deficits Induced by Developmental Pb2+ Exposure. Adv Exp Med Biol. 2017;975 Pt 1:39-55. doi: 10.1007/978-94-024-1079-2_4. PMID: 28849442.
[47] NIMH. The Teen Brain: 7 Things to Know. The National Institute for Mental Health. Available at: https://www.nimh.nih.gov/health/publications/the-teen-brain-7-things-to-know#:~:text=Though%20the%20brain%20may%20be,last%20brain%20regions%20to%20mature.; accessed on October 5, 2022.

greater with increases in blood lead levels and/or with increases in the duration of lead exposure.

31. This ends my response to the questions posed. I reserve the right to amend my expert report and update my opinions if new or additional information becomes available.

IV. LIST OF ALL PUBLICATIONS IN THE PREVIOUS 10 YEARS

A. See Exhibit 1 (my CV; includes all publications in the previous 10 years).

V. LIST OF ALL CASES

A. See Exhibit 2 attached hereto (all cases in the last 4 years).

VI. STATEMENT OF COMPENSATION PAID

A. See Exhibit 3 attached hereto (fee schedule, recent invoice).

VII. LIST OF REFERENCES

A. See Exhibit 4 attached hereto (compilation of all footnotes in this document).

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and recollection.

Executed this 18th day of October, 2022, in Los Angeles, CA.

By: _____
Howard Hu, M.D., M.P.H., Sc.D.

EXHIBIT 1

CURRICULUM VITAE Date Prepared: October, 2022

NAME: Howard Hu
PRIMARY AFFILIATION: Keck School of Medicine, University of Southern California
SECONDARY AFFILIATIONS: School of Public Health, University of Michigan; School of Public Health, University of Washington

CONTACT: Howard Hu, M.D, M.P.H., Sc.D.
Email: howard.hu@med.usc.edu

TABLE OF CONTENTS

EDUCATION:

9/1973-6/1976	Biology	B.Sc.	Brown University
9/1977-6/1982	Medicine	M.D.	Albert Einstein College of Medicine
9/1979-6/1980 (degree in 6/1982*)		M.P.H. (Occ Hlth)	Harvard School of Public Health
9/1985-6/1986	Epidemiology	M.S.	Harvard School of Public Health
7/1986-6/1990	Epidemiology	Sc.D.	Harvard School of Public Health

* Awarding of the Harvard M.P.H. to medical students is delayed until the M.D. degree is conferred

POSTDOCTORAL TRAINING:

Research Fellowships

7/1987-6/1988 Occupational Health Research Fellow, Dept. of Environmental Health
Harvard School of Public Health

Internship and Residencies

7/1982-6/1983	Intern in Medicine	Boston City Hospital
7/1983-6/1984	Junior Assistant Resident, Internal Medicine	Boston City Hospital
7/1984-6/1985	Senior Assistant Resident, Internal Medicine	Boston City Hospital
7/1985-6/1987	Resident, Occupational Medicine	Harvard School of Public Health

CERTIFICATION AND LICENSURE:

1984	Massachusetts Medical License Registration
1985	American Board of Internal Medicine, Diplomate
1987	American Board of Preventive Medicine, Diplomate (Occupational Medicine)
2006	Michigan Medical License Registration
2013	College of Physicians & Surgeons of Ontario
2018	Washington State Medical License Registration
2021	California State Medical License Registration (in process)

ACADEMIC APPOINTMENTS:

9/1988-6/1992	Instructor in Medicine Department of Medicine, Harvard Medical School
9/1988-6/2006	Associate Physician (Clinical and Research), Channing Laboratory, Department of Medicine, Brigham & Women's Hospital
9/1990-6/1994	Assistant Professor of Occupational Medicine Department of Environmental Health, Harvard School of Public Health
7/1992-6/1997	Assistant Professor of Medicine

	Department of Medicine, Harvard Medical School
7/1994-6/2002	Associate Professor of Occupational Medicine Department of Environmental Health, Harvard School of Public Health
7/1997-8/2006	Associate Professor of Medicine Department of Medicine, Harvard Medical School
7/2002-8/2006	Professor of Occupational and Environmental Medicine (tenured) Department of Environmental Health, Harvard School of Public Health
9/2006-6/2012	Chair and Professor of Environmental Health Sciences (tenured), Department of Environmental Health Sciences, University of Michigan School of Public Health
9/2006-8/2009	Adjunct Professor of Occupational and Environmental Medicine Department of Environmental Health, Harvard School of Public Health
9/2006-6/2012	Research Associate Physician, Channing Laboratory, Department of Medicine, Brigham & Women's Hospital
5/2007-2012	Professor of Epidemiology, University of Michigan School of Public Health
5/2007-2012	Professor of Internal Medicine, University of Michigan Medical School
1/2009-2012	NSF International Endowed Department Chair, University of Michigan School of Public Health, Department of Environmental Health Sciences
7/2012-2018	Professor of Environmental Health, Epidemiology and Global Health (tenured) Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada (on sabbatical/administrative leave, 2017-2018)
7/2012-2018	Professor, School of Medicine, University of Toronto, Toronto, Ontario, Canada
7/2012-	Adjunct Professor, Department of Environmental Health Sciences, University of Michigan School of Public Health
7/2012-2013	Director, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada
7/2013-6/2018	Founding Dean, Dalla Lana School of Public Health, a Faculty of the University of Toronto, Toronto, Ontario, Canada
7/2018-	Affiliate Professor (started as a Visiting Scholar, transitioned in 2018), Department of Occupational and Environmental Health Sciences, University of Washington School of Public Health, Seattle, WA
7/2020-	Professor (tenured) and Flora L. Thorton Endowed Chair, Department of Population and Public Health Sciences (previously, Department of Preventive Medicine), Keck School of Medicine, University of Southern California, Los Angeles, CA

ADMINISTRATIVE APPOINTMENTS:

7/1991-6/2006	(Founding) Director, Metals Epidemiology Research Group, Channing Laboratory, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, and Department of Environmental Health, Harvard School of Public Health
7/1992-6/1995	Director, Commission to Investigate the Health and Environmental Effects of Nuclear Weapons Production, International Physicians for the Prevention of Nuclear War
7/1996-6/2006	Director, Residency Program in Occupational and Environmental Medicine, Harvard School of Public Health
7/1996-8/2006	Director, Occupational and Environmental Medicine Core, National Institute for

Occupational Safety and Health Educational Resource Center at the Harvard School of Public Health

7/1998-6/2004 (Founding) Medical Editor, Environmental Health Perspectives (official journal of NIEHS)

7/2000-8/2006 Associate Director, the Harvard NIEHS Environmental Sciences Center, Harvard School of Public Health

7/2004-6/2009 (Founding) Principal Investigator and Director, Harvard Center for Children's Environmental Health and Disease Prevention Research (co-PI and co-Director after 9/1/08)

9/2006-6/2012 Chair, Department of Environmental Health Sciences, University of Michigan School of Public Health

9/2006-2012 Director, Occupational Epidemiology Core, NIOSH Education and Research Center, University of Michigan

9/2006-2012 Co-Director, Michigan-Harvard/Harvard-Michigan Metals Epidemiology Research Group

7/2009-2011 Director, NIA T32 Training Grant in Aging and Public Health, University of Michigan School of Public Health

1/2010-2012 Chair, Faculty Steering Committee on Global Health, University of Michigan School of Public Health

4/2011-2012 (Founding PI) and Director, University of Michigan NIEHS P30 Core Center.

7/2012-2013 Director, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

7/2013-6/2017 Founding Dean, Dalla Lana School of Public Health, a Faculty of the University of Toronto, Toronto, Ontario, Canada

7/2020- Flora L. Thornton Endowed Department Chair, Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA

CLINICAL APPOINTMENTS:

7/1985-6/1987 Attending Physician, Emergency Department, Whidden Memorial Hospital

7/1985-6/1988 Assistant Visiting Physician, Department of Medicine, Boston City Hospital

1/1985-6/2006 Consultant in Occupational and Environmental Medicine, Center for Occupational and Environmental Medicine, Northeast Specialty Hospital (formerly known as the Olympus Specialty Hospital, the Massachusetts Respiratory Hospital, and Norfolk County Hospital).

3/1987-9/1987 Attending Physician, Occupational Health Program, University Hospital/Boston University Medical Center

7/1988-9/2006 Associate Physician, Brigham and Women's Hospital

7/1990-6/1995 Occupational/Environmental Medicine Consultant, Brigham and Women's Hospital Employee Health Services

7/2007-2012 Associate Physician, Division of General Medicine, Department of Medicine, University of Michigan Health System

1/2019-2020 Staff Physician, RotaClinic-Lake City, Seattle, WA

2021 (pending) Associate Physician, Keck Medical Center

OTHER ACADEMIC POSITIONS and MAJOR VISITING APPOINTMENTS:

7/1987-6/1990 Visiting Physician, South Cove Health Center, Boston (Chinatown)
7/1996-8/2006 Associate, Center for Health and the Global Environment, Harvard Medical School
2/1997 Alice Hamilton Visiting Professor, Division of Occupational and Environmental Medicine, Department of Medicine, University of California at San Francisco
11/2000- Visiting Scientist, Sri Ramachandra Medical College and Research Institute
7/2010- Senior Consultant, Tianjin Centers for Disease Control and Prevention, Tianjin, China
10/2012- Visiting Professor, Shanghai Key Laboratory of Children's Environmental Health, Xinhua Hospital, Shanghai Jiao-Tung University, China
7/2013-6/2016 Visiting Professor, Shanghai Jiao Tong School of Medicine, China
5/2015- Affiliate Scientist to the Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada

MAJOR RESEARCH INTERESTS:

1. Environmental and molecular epidemiologic research related to heavy metals, potential endocrine disruptors, other neurotoxicants, carcinogens, and their impact on adverse health outcomes.
2. Gene-environment interactions; epigenetic dysregulation
3. Fetal/early life exposures and long-term effects
4. Aging-environment interactions
5. Health disparities
6. Health and human rights
7. Health, climate change, sustainability, and the global environment
8. "Big Data" for population health
9. Attitudes, behaviors, the immune response to infection and vaccines, and susceptibilities related to COVID19.

GRANTS (as PI, Co-PI, or primary mentor only):

Past Funding:

1980 (summer) Montefiore Hospital, Bronx NY,PI; $2,000 (approx)
A study of rural and occupational health in Tulua, Colombia, South America
1982 (summer) Albert Einstein College of Medicine, PI; $3,000 (approx)
A study of occupational/environmental health in Shanghai, China
7/1987-6/1989 NIEHS Center Grant ES00002 Pilot Project, PI; $12,000
The Long-term Renal and Neurologic Effects of Childhood Plumbism
7/1989-6/1990 NIEHS subcontract 7083-1, PI; $50,000 (approx)
The Use of X-Ray Fluorescence to Measure Lead Burden and Childhood Lead Exposure

7/1990-6/1992 Agency for Toxic Substances and Disease Registry, PI; $150,000 (approx)
"Clinical Environmental/ Occupational Medicine Research Fellowship Award",
7/1990-6/1991 NIEHS Center Grant ES00002 Pilot Project, PI; $12,000
The Metabolic Effects of Pregnancy and Lactation on Lead Burden
7/1990-6/1991 Harvard School of Public Health Basic, PI
Research Support Grant; $10,000
K-X-Ray Fluorescence Measured Lead Burden
10/1991-11/1991 NIOSH Special Grants, PI; $50,000 (approx)
The Carpenters Lead Project
4/1991-3/1996 NIEHS/R01, PI; $2,200,000 (approx)
The Epidemiology of Lead, Diet and Blood Pressure
7/1991-6/1996 NIEHS/R01 supplement, PI; $240,000 (approx)
The Epidemiology of Lead, Diet and Blood
Pressure--Research Supplement for Minority Investigator
7/1992-6/1995 NIEHS/R01 (Office of Research on Women), PI; $200,000 (approx)
Lead and Hypertension in Women
7/1993-6/1996 NIEHS/subcontract, PI; $150,000 (approx)
Exposure to Neurotoxins as Risk Factors for Amyotrophic Lateral Sclerosis
7/1995-6/1998 State of Washington, Department of Labor, PI; $350,000 (approx)
SPECT Imaging of the Brain in Patients with Multiple Chemical Sensitivity
Syndrome and Controls
7/1996-6/1997 NIEHS Center Grant ES00002 Pilot Project, PI; $15,000
Electrocardiographic abnormalities in association with low-level lead exposure
among middle-aged to elderly men: the Normative Aging Study
4/1995-3/2000 NIEHS Project PI (Program Project PI: Richard Monson); $1,800,000 (approx)
Lead Exposure, Accumulation in Bone, and Reproductive Toxicity Among Men and
Women In Mexico
4/1995-3/2000 NIEHS Project PI (Program Project PI: Richard Monson); $1,900,000 (approx)
Lead Exposure, Accumulation in Bone, and Cognitive Toxicity Among Elderly Men
and Women
6/1997-5/2002 NIEHS/R01 ES05257 PI; $2,312,274
Lead Biomarkers, Aging, and Chronic Disease
7/1997-6/1999 NIEHS Center Grant ES00002 Pilot Project, PI; $10,000
The effect of genetic polymorphisms of metallothionein-IIA on mRNA levels in
middle-aged to elderly men: the Normative Aging Study
7/1998-6/2003 NIEHS/R01 PI (with no-cost extension; 5R01ES007821); $2,291,833
Lead Dose Biomarkers, Reproduction, and Infant Outcomes
7/1999-6/2000 NIEHS Center Grant ES00002 Pilot Project, co-PI; $14,000
Magnetic Resonance Spectroscopy in the Evaluation of Lead Neurotoxicity: the
Normative Aging Study
7/2000-6/2001 MAVERIC (Massachusetts Area Veterans Epidemiology Resource and Institute
Center) Pilot Project PI (with Dr. Robert Wright, co-PI); $10,000
The Use of Magnetic Resonance Spectroscopy in Lead Poisoning
7/2000-6/2001 NIOSH Center Grant Pilot Project, PI (with Dr. Robert Wright, co-PI); $12,000
Interaction between ApoE Genotype and Lead Exposure in the Development of

Cognitive Impairment
7/2002-6/2004 The Rasmussen Foundation/Health Care Without Harm; $50,000
Medical Use of Phthalate Containing Products in the Neonatal Intensive Care Unit and Biomarkers of Neonatal Phthalate Metabolites
7/2002-6/2003 NIEHS Center Grant Pilot Project, PI; $8,000
Vitamin D Receptor Gene and Bone Lead in Reproduction
3/2004-2/2005 The Critelli Family Foundation; $10,000
Review of Environmental Cadmium Exposure and Toxicity
4/2000-3/2007 NIEHS Project Leader (Program Project PI: Richard Monson; 5P01ES05947); $2,472,677; Controlled Trial in Pregnancy of Dietary Supplements for the Suppression of Bone Resorption and Mobilization of Lead into Plasma (no cost extension)
4/2000-3/2007 NIEHS Project co-Leader (Program Project PI: Richard Monson; 5P01ES05947); $1,210,000 (approx); A Community-Based Study of Lead Exposure Pathways, Biomarkers of Dose, Health Effects, and Phytoremediation Strategies at the Tar Creek Superfund Site (no cst extension)
4/2002-9/2007 NIEHS/R01 PI (5R01ES010798); $3,011,295
Gene-Metal Interactions and Parkinson's Disease
10/2003-9/2007 NCMHI/P20 Project Leader (MD000501-01; Hughes Harris, PI); $828,781(Project)
"FAMU and Harvard Center for Health and Health Care Disparities"
8/2003-7/2008 NIEHS/R01 PI (2R01ES05257-11A2); $3,357,424 (bécame co-PI in 2007 after move to University of Michigan)
Lead-Gene Interactions and Cognition
6/2004-3/2009 NIEHS/P01 PI (5 P01ES012874-01); $6,662,670 (became co-PI in 2006 after move to University of Michigan)
Metals Mixtures and Children's Health (Center for Children's Environmental Health and Disease Prevention Research)
7/2002-12/2009 NIH/R03 PI (1R03TW005914; no cost ext through 2008); $192,000 (approx)
Lead, Genes, and Cognition in Children in Chennai, India
9/2006-7/2011 NIEHS/R01 PI (R01ES0007821); $3,116,831
Fetal Origins of Neurobehavior: Lead and Cholesterol Metabolism Interactions
7/2006-6/2011 NIEHS/R01 co-PI (R01ES013744; PI Wright), $3,200,000
Stress, Lead, Iron Deficiency and Neurodevelopment
7/2006-6/2011 NIEHS/R01 co-PI (RO1ES014930; PI Wright), $2,800,000
Metal Mixtures and Neurodevelopment
2/2008-2/2010 Michigan Institute for Clinical and Health Research (MICHR; home of the UM CTSA; UL1RR024986) Pilot Project PI; $26,000 (no cost extension)
Epigenetics of Early Life Events and Environmental Toxicants
4/2009-4/2010 Michigan Alzheimer's Disease Research Center Pilot Project PI, $25,000
Environment, Epigenetics and Alzheimer's Disease (no cost extension)
12/2009-12/2010 University of Michigan Center for Global Health Pilot Project PI, $25,000
Climate Variability and Impacts on Mortality and Morbidity in Chennai, India: A Pilot Project Stemming from the 2009 U.S.-India Workshop on Climate Change and Public Health, Goa India (no cost extension)

9/2009-9/2010 Michigan Institute for Clinical and Health Research (MICHR; home of the UM CTSA; UL1RR024986) Pilot Project PI; $26,000 (no cost extension)
Epigenetics and Epigenomics in the Etiology of Alzheimer Disease

7/2008-6/2011 NIA/T32 PI (T32AG027708); $450,000
Interdisciplinary Training Program in Aging and Public Health

4/2010-3/2015 NIEHS P42 Superfund Co-Inv, Project 2, Co-investigator (P42ES017198; PI: Alshawabkeh, Project 2 Leader: Meeker) Puerto Rico Testsite For Exploring Contaminant Threats, $12,000,000

4/1/2011-6/2015 NIEHS Core Environmental Health Sciences Center, Founding PI and Director (until 2012; now consultant; P30 ES017885), $ 4,620,100;
"Lifestage Exposures and Adult Disease"

4/2010-3/2014 NIEHS/EPA P20 Co-PI and Clin Health Specialist (P20 ES018171; PI Peterson) Formative Children's Environmental Health and Disease Prevention Center, $1,959,960; "Perinatal Exposures, Epigenetics, Child Obesity & Sexual Maturation"

7/1/2013-6/30/2014 CIHR, Canadian Institute for Health Services and Policy Research; Planning Grants-Priority Announcement:Partnerships for Health System Improvement; PI, $24,992
"The Surviving Opioid Overdose with Naloxone (SOON) Project and Roundtable"

07/1/11-06/30/16 NIEHS K01 ES019909 (co-mentor; PI: Somers)
"Immune dysfunction associated with early life heavy metal exposure"

4/1/12-3/30/17 NIEHS R01ES013744 (consultant; PI: Wright; Mt Sinai School of Medicine)
"Stress-Lead Interactions and Child Development"

7/1/2012-7/1/2017 European Commission (EC), Funded under FP7-Health, Project 304925, co-Investigator; PI, epidemiologic studies, $6,000,000 E
"A novel micronutrient-based strategy to prevent hearing impairments: test and road to market for age-related hearing loss and preservation of residual hearing"

6/1/2012-7/1/2020, 1R01ES021446, PI, $4,140,000 (parent + supplement awards);
"Prenatal and Childhood Exposure to Fluoride and Neurodevelopment"

5/15/2015-5/15/2020 Health Canada; PI, $200,000 (Phase 1); $1,400,000 (proposed Phase 2) "A Community-based First Nation Study of Cancer and the Environment in Northern Ontario"

Current Funding

5/1/2021-4/30/2022 Environmental Pollutant Risk Factors for Worse COVID-19 Related Clinical Outcomes, PI, $49,999; the Southern California Environmental Health Sciences Center Pilot Project Program, University of Southern California, Los Angeles, CA

3/8/2021-3/8/2022 The USC SARS-CoV-2 Vaccination Campaign Research Initiative: Uptake, Markers and Determinants of Effectiveness, Subsequent Behaviors, PI, $1,200,000; The Keck COVID-19 Research Fund in the Keck School of Medicine; USC Office of the Provost; USC Office of Research.

12/31/2020-6/30/2022 The Los Angeles Pandemic Surveillance Cohort Initiative, PI, $ 1,997,934; The Los Angeles County Public Health Departmen, PH-003903-W2/U.S. Centers for Disease Control and Prevention Cooperative Agrement US0CK000498.

11/1/2020-10/30/2021 The Population Health COVID-19 Pandemic Research Center, co-PI,

$320,000, The Keck Medicine COVID-19 Research Initiative; the Keck Foundation,
3/24/2020-2/28/2021 Pilot Project Proposal for Rapid Response Funding, University of Michigan NIEHS P30 Core Sciences Center (co-PI); $6,250, "Environmental Cadmium and Influenza-related Mortality in NHANES: An Environment-Infectious Disease Interaction Study with Implications for Strategies for Reducing COVID-19-related Morbidity and Mortality"
4/1/13-3/31/23NIEHS/EPA P01ES022844 (co-inv; PI: Peterson at the University of Michigan) "Lifecourse Exposures & Diet: Epigenetics, Maturation & Metabolic Syndrome."
7/1/16-6/30/21 CIHR (co-PI; Director; PI: Jeffrey Brook at the Dalla Lana School of Public Health) $4,700,000 CNDN
"CANadian Urban Environmental (CANUE) Health Research Consortium"
9/1/16-8/31/21 NIH 5R01ES026033-02, (Consultant/Co-investigator; PI: Arora at Mt. Sinai School of Medicine) $648,000 "Novel Biomarker to Identify Critical Windows of Susceptibility to Metal Mixture"
9/1/17-6/30/22 NIH R24ES028502 (Consultant/Co-investigator; PI: Peterson at the University of Michigan, "E3GEN: Multigenerational Effects of Toxicant Exposures on Life Course Health and Neurocognitive Outcomes in the ELEMENT Birth Cohorts"; $2,009,022

Applications Under Review

7/1/2022-6/30/2027 competitive renewal of R01ES021446, PI, $3,704,071
"Exposure to Fluoride in Pregnancy: Impacts on Maternal Thyroid Function and Cognitive, Non-cognitive, and Life Outcomes in Young Adult Offspring"

New Application in Progress

P01 (no number yet assigned), MPI, $8.4M
"Post-acute SARS-Cov-2 Neuro Syndrome: A Transdisciplinary Investigation of Potential Mechanistic Pathways Among Subjects from a Long-Running Multi-ethnic Cohort"

Wellcome Trust, xxx, MPI
Addressing Two Critical Gaps in Understanding the Impacts of Lead Exposure on the Global Burden of Disease: (a) Impacts on Cardiovascular Disease; (b) Exposures and Sources in Low and Middle-Income Countries

Wellcome Trust, MPI
"Quantifying the Cognitive and Economic Benefits of Reducing Air Pollution to Achieve Climate Change Mitigation"

R01ES031820 (app # pending), multiple PI, $3,086,477
Perinatal Maternal Heavy Metal Burden and Offspring Blood Pressure

HONORS AND AWARDS:

1978-1982 National Health Service Corps Scholarship
1985-1988 National Research Service Award
1990-1992 Agency for Toxic Substances and Disease Registry Clinical Environmental Medicine Award
1994 Will Solimene Award of Excellence, American Medical Writers Association, for: Chivian E, McCally M, Hu H, Haines H, eds. *Critical Condition: Human Health and the Environment*. Cambridge: The MIT Press, 1993.
1997 Alice Hamilton Lecturer, University of California at San Francisco
1998 First Prize for Best Infant Nutrition Research, Instituto Danone, Mexico (for González-Cossío T, Peterson KE, Sanín L, Fishbein SE, Palazuelos E, Aro A, Hernández-Avila M, Hu H. "Decrease in birth weight in relation to maternal bone lead burden." Published in *Pediatrics*)
1999 National Institute for Environmental Health Sciences "Progress and Achievement of the Year Award", 1998-1999
1999 True Memorial Lecturer, Maine Medical Center, Portland ME.
2000-2001 Faculty Sabbatical Award, Harvard School of Public Health
2000-2001 Senior Fulbright Scholar in India
2001 Hoopes Prize, Faculty Mentorship (for Senior Thesis of Charles Lin, "More than Black and White: Lead Poisoning as an Environmental Justice Issue in Boston")
2003 Best Paper in Preventive Medicine by a Medical Student (for Senior Thesis of Vanitha Janakiraman; Janakiraman V, Hu H, Mercado-Garcia A, Hernandez-Avila M. A randomized crossover trial of nocturnal calcium supplements to suppress bone resorption during pregnancy. Am J Prev Med 2003;24:260-4.). American College of Preventive Medicine, Ulrich and Ruth Frank Foundation for International Health.
2004 Das Travel Grant Award, The South Asia Initiative, Harvard University (for Travel in India)
2005 Adolph G. Kammer Merit in Authorship Award, the American College of Occupational and Environmental Medicine (for Rhodes D, Spiro A, Aro A, Hu H "Relationship of Bone and Blood Lead Levels to Psychiatric Symptoms: The Normative Aging Study", Published in the *Journal of Occupational and Environmental Medicine*)
2006 Teacher of the Year Award, Occupational/Environmental Medicine Residents, Harvard School of Public Health
2006 Harriett Hardy Award, the New England College of Occupational and Environmental Medicine
2009 Linus Pauling Award for Lifetime Achievements, American College for the Advancement of Medicine
2011 Award for Excellence, American Public Health Association
2015 John R. Goldsmith Award for Outstanding Contributions to Environmental Epidemiology, International Society for Environmental Epidemiology
2016 Election to Fellowship, Canadian Academy of Health Sciences

MEMBERSHIPS IN PROFESSIONAL SOCIETIES

Memberships

1981- American Public Health Association (APHA)
1982-2006 Massachusetts Coalition for Occupational Safety and Health
1983-1989 American College of Physicians
1985- Physicians for Social Responsibility
1987- Physicians for Human Rights
1990- International Society for Environmental Epidemiology (ISEE)
1990-2000 American Association for the Advancement of Science
1990-2006 Association of Occupational and Environmental Clinics (AOEC)
1991- International Physicians for the Prevention of Nuclear War (IPPNW)
1994-1996 Society for Occupational and Environmental Health (SOEH)
2000-2012 American College of Occupational and Environmental Medicine (ACOEM)
2009-2012 Society of Toxicology
2012-2018 Canadian Public Health Association (CPHA)
2020- Washington State Medical Association

Committee Assignments

1981-1982 Program Committee, Occupational Safety and Health Section, APHA
1987-1988 Program Committee, Asian-American Caucus, APHA
1992-1998 Membership Committee, ISEE
1995-1998 Quality Assurance Committee, AOEC
1997-1998 Program Committee, 1998 Superfund Basic Research Program, Annual National Meeting
2001-2006 Program Committee, New England College of Occupational and Environmental Medicine Annual Meetings

EDITORIAL POSITIONS AND BOARDS:

1977-1982 Einstein Community Health Newsletter
1988-1992 Bookreview Co-Editor, Section on Occupational Safety and Health, Am Public Health Assoc.
1993- Journal of Health and Human Rights
1998- Environmental Health Perspectives (Founding Medical Editor, 1998-2004; Associated Editor, 2004-)
2004- American Journal of Industrial Medicine
2007-2009 Faculty of 1000 Medicine
2017- Current Environmental Health Reports
2017- Faculty of 1000 Medicine

PEER REVIEW SERVICE

American Journal of Clinical Nutrition
American Journal of Epidemiology
American Journal of Industrial Medicine
Archives of Environmental and Occupational Health
Biomed Central
Circulation
Environmental Epidemiology
Environmental Health
Environmental Health Perspectives
Environment International
Environmental Research
Epidemiology
Indian Journal of Medical Research
Journal of Health and Human Rights
Journal of the American Medical Association
Kidney International
Lancet
New England Journal of Medicine
Pediatrics
PLOS One
Science of the Total Environment

TEACHING:

1. LOCAL CONTRIBUTIONS (at the Harvard School of Public Health, 1985-2006)

1985-	"Toxicology of the Kidney and Urinary Tract" Guest Lecturer for TOX204a,b
1988-	"Occupational Health" Guest Lecturer for EH201a,b
1989-1992	"Lead Toxicology" Guest Lecturer for TOX204a,b
1990-	Grand Rounds in Occupational/Environmental Medicine Director
1990-2000	Introduction to Occupational and Environmental Medicine (EH232c,d) Course director, lecturer
1990-	"The Epidemiology of Lead Exposure, Dose, and Toxicity" Guest Lecturer for EPE215c,d and EPE215t
1990-	"Solvent toxicity" Fundamentals of Industrial Hygiene, Continuing Education Department
1992	"Current Research on Lead", Metals Epidemiology Research Group Seminar

Presenter

1992 "Lead Poisoning Without a Known Source in a Hyperthyroid Patient"
Case discussant, Grand Rounds in Occupational and Environmental Medicine

1992- "Biological Markers of Lead Dose"
Guest Lecturer, EHE280c,d

1994- "Screening for Lead Toxicity"
Guest lecturer, EPI227d

1994- "Lead Exposure and Biological Monitoring"
Guest Lecturer, ID263b

1994- "Case Study: Lead"
Guest Lecturer and Case Discussant, EH202d

1996- Introduction to Environmental Health (EH201b)
Course director and lecturer

1997- Human Health and Global Environment Change (EH278a,b)
Course Co-developer, Co-director, and lecturer

Hospital courses and Invited Teaching Presentations (Harvard-affiliated Hospitals)

1990 Guest Lecturer on Occupational Medicine
Residency Program, Department of Medicine, Brigham and Women's Hospital

1994 Speaker, Grand Rounds; "Is Lead a Ticking Time Bomb?"
Department of Obstetrics and Gynecology, Brigham and Women's Hospital

1994 Speaker, Grand Rounds; "Is Lead a Ticking Time Bomb?"
Department of Medicine, Brockton V.A. Hospital

1994 Speaker, Symposium on Preventive Medicine and Clinical Epidemiology,; "Is Lead a Ticking Time Bomb"; Brigham and Women's Hospital

1995 Discussant, "Multiple Chemical Sensitivity", Occupational/Environmental Medicine Grand Rounds, Occupational Health Program, Harvard School of Public Health

1996 Guest lecturer, "Lead Toxicity as a Paradigm for a Regional and Global Health Hazard", Environmental Health Student Group, Holmes Society, Harvard Medical School

1997 Speaker, "Mobilization of maternal bone lead as a hazard to the fetus", Grand Rounds, Dept. of Neonatology, Beth Israel Hospital, Boston, MA

2000 Guest lecturer, "Update on Lead Toxicity Research", Program in Pediatric Toxicology, Children's Hospital

2000 Discussant, "Adult Lead Toxicity", Weekly Case Round, Department of Medicine, Brigham and Women's Hospital, Boston.

2000 Lecturer, "Update on Lead Toxicity, Hypertension, and Chronic Renal Failure", Renal Rounds, Division of Nephrology, Department of Medicine, Brigham and Women's Hospital, Boston.

2002 Lecturer, "Maternal Bone Lead as a Threat to Fetal Development", Program in Neonatology, Beth Israel-Deaconness Hospital, Boston, MA

Doctoral student committees
Chair and member:

Dr. Rokho Kim	Dr.P.H. Occupational Health and Epidemiology, '96
Dr. Yawen Cheng	Sc.D. Epidemiology, '98
Dr. Sharon Tsaih	Sc.D. Epidemiology, '99
Dr. Hung Yi Chuang	Sc.D. Occupational Health, '99
Dr. Adrienne Ettinger	Sc.D. Environmental Health, '03
Dr. Florence Wang	Sc.D. Environmental Health, '05
Dr. Sung K. Park	Sc.D. Environmental Health, '05
Dr. Pradeep Rajan,	Sc.D. Occupational Health, '06

Member/Advisor:

Dr. How Ran Guo	Sc.D. Occupational Health, '94
Dr. Joshua Cohen	Sc.D. Health Policy and Management, '94
Dr. Jane Hoppin	Sc.D. Environmental Health, '95
Dr. Salma Elreedy	Sc.D. Environmental Health, '97
Dr. Mary Jean Brown	Sc.D. Maternal and Child Health, '00
Dr. Brisa Sanchez	Sc.D. Biostatistics, '06
Dr. Ami Zota	Sc.D. Environmental Health, '07
Dr. Ananya Roy	Sc.D. Environmental Health, '08
Dr. Elissa Wilker	Sc.D. Environmental Health, '09

Post-doctoral fellow mentor:

Dr. Marinelle Payton (Channing Lab), Dr. Susan Korrick (Channing Lab), Dr. Rokho Kim (Channing Lab), Dr. Viji Potula (HSPH Research Fellow), Dr. Barbara Nowak (Visiting Scientist from Silesian University School of Medicine, Poland), Dr. Robert Wright (Channing Lab), Dr. Ming Tsuang Wu (HSPH Research Fellow), Dr. Yawen Cheng (Channing Lab), Dr. Geeta Mathur (neonatology fellow at the Brigham and Women's Hospital), Dr. Sri Hari Bojja (HSPH Research Fellow), Dr. Hae-Kwan Cheong (Visiting Scientist from Dongguk University School of Medicine, S. Korea), Dr. Sahar Elmarsafawy (HSPH Research Fellow), Dr. Jing Lu (Visiting Scientist from the Chinese Academy of Preventive Medicine), Dr. Dieter Affeln (Occ/Env Med Fellow), Dr. Ahmed Gomaa (Occ/Env Med Fellow), Dr. Chris Leffler (Occ/Env Med Fellow), Dr. Ronald Dykeman (Occ/Env Med Fellow), Dr. Uma Dhanabalan (Occ/Env Med Fellow), Dr. Hsien-Wen Hsu (Occ/Env Med Fellow), Dr. Betty Ann Cohen (Occ/Env Med Fellow), Dr. Arvin Chin (Occ/Env Med Fellow), Dr. Daniel Rhodes (Occ/Env Med Fellow), Dr. Richard Wittman (Occ/Env Med Fellow), Dr. Sun-Dong Lee (Visiting Scientist from Sangji University, Korea), Dr. Ronald Green (Occ/Env Med Fellow), Dr. Erma Lawson (Environmental Health Fellow), Dr. Marc Weisskopf (Environmental Health Fellow), Dr. Bridget Bagert (Occ/Env Med Fellow), Dr. John Jarrell (Visiting Scientist from University of Calgary), Dr. Jennifer Weuve (Environmental Health Fellow), Dr. Karen Chou (Visiting Scientist from Michigan State), Dr. Nitin Jain (Channing Laboratory Fellow), Dr. Adrienne Ettinger (Children's Center Scientist), Dr. Sam Myers (Fellow in Alternative and Complementary Medicine), Dr. Marcelo Targino (Occ/Env Med Fellow), Dr. Manish Arora (Post-doctoral fellow from University of Sydney), Dr. Huiling Nie (Post-doctoral fellow from McMaster University).

Other faculty mentorship:

Elizabeth Rubinstein (HMS Summer research), Alicia Marier (HMS Summer research), Vanitha

Janakiraman (HMS Summer research), Young-Sook Lim (Harvard College Summer research), Charles Lin (Harvard College Senior thesis research), Ed Hsieh (Harvard College Summer research), Naveen Thomas (Emory University Medical School Senior thesis research). Shreekrishna Akilesh (Harvard Dental School summer research), Christine Pace (HMS Summer research)

Advisory and supervisory responsibilities

1985-1987	Attending Physician, outpatient general medicine clinic, Boston City Hospital; weekly precepting for housestaff and medical students
1990-2006	Preceptor, Residency in Occupational and Environmental Medicine, Harvard School of Public Health at the Mass Respiratory Hospital
1990-2006	Advisor to general M.P.H. students, Harvard School of Public Health.

2. LOCAL CONTRIBUTIONS (at the University of Michigan, 2006-2012)

2006-	Principles of Environmental Health (EHS-500) Course director and lecturer
2006-	Environmental Epidemiology (EHS-608) Guest lecturer on birth cohorts and environmental epidemiology
2006-	Occupational and Environmental Disease (EHS-501) Guest lecturer on metals exposure and health effects; Course Director (2009-)
2007-	Metals Exposure, Biomarkers and Toxicity: A Multi-disciplinary Environmental Epidemiology Approach (EHS-698 reading course) Course director and lecturer
2008-2009, 2010-2011	Topics in Environmental Health Sciences (EHS-688) Course director and lecturer
2009	Occupational and Environmental Disease (EHS-501) Course director and lecturer
2009-	On-line (Long-distance Foundations in Public Health Certificate Program): Principles of Environmental Health (EHS-500-801) Course director and lecturer
2009	Introduction to Public Health (HMP-200) Guest lecturer on environmental health
2009-	Seminars in Aging and Public Health (EPID 813) Course director and lecturer
2011	Seminar on Public Health in China (HMP-xxx) Guest lecturer on “Environmental Health in China”

Post-doctoral fellow mentor:

Dr. Sung Kyun Park (Environmental Health Sciences Fellow, now Research Assistant Professor), Dr. Brisa Sanchez (Biostats Research Assistant Professor, now Assistant Professor), Dr. Richard Pilsner (Robert Wood Johnson Health & Society Fellow), Dr. Aimin Zhang (Environmental Health Sciences Fellow, Toxicology Training Grant), Dr. Ananya Roy (Environmental Health Sciences Fellow), Dr. David Cantonwine (Reproductive Sciences Fellow).

Doctoral Student Advisor (principal)

David Cantonwine	Ph.D.	Environmental Health Sciences (2009)
Myriam Afeiche	Ph.D.	Environmental Health Sciences (co-mentor with Karen Peterson; 2010)
Yoon-Hyeong Choi	Ph.D.	Environmental Health Sciences (co-mentor with Sung Kyun Park; 2011)
Katie F. Bush	Ph.D.	Environmental Health Sciences (co-mentor with Marie O'Neill; 2011)
Kelly Bakulski	Ph.D.	Environmental Health Sciences (2012)
Gamola Fortenberry	Ph.D.	Environmental Health Sciences (co-mentor with John Meeker; 2013)
Siying Huang	Ph.D.	Environmental Health Sciences (2013)
Deena Thomas	Ph.D.	Environmental Health Sciences (2014)
Rebecca Tutino	Ph.D.	Environmental Health Sciences (2015)
Zishaan Farooqui	Ph.D.	MD-PhD Medical Scientist Training Program (2015)

Masters Student Thesis Advisor

Bradley Lampe (OEE), Troy Meissner (OEE), Pheba Alexander (OEE), Brian Davis (OEE & HBHE), Aaron Leftwich (OJOC program), Suengwon Lee (Nutrition), Allen Zhong (OEE), Graham Newman (OEE), Jacqueline Barkoski (OEE)

Undergraduate Thesis Advisor

Lauren Schwartz (Neuroscience, LSA)

3. LOCAL CONTRIBUTIONS (at the University of Toronto, 2012-2017)

2012	Determinants of Community Health (Faculty of Medicine) Guest lecturer on 'The Future of Medicine & Public Health in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World".
2012-	CHL5004H Introduction to Public Health Guest lecturer on "The Future of Public Health (and Your Role !) in a Hot, Flat, Crowded…and Diverse, Aging, Stratified, Urbanized, Polluted, Thirsty, Hungry, Debt-Ridden World". "What is Public Health?", "Climate Change and Health"
2012-	CHL 5912F Industrial Toxicology. Guest lecturer on the "Toxicology of Metals".
2013-2014	Department of Family & Community Medicine "Building Blocks" (short course for International post-graduate primary care trainees); Guest lecturer on "Public Health & Primary Care"
2013-	CHL5701H Doctoral Seminar, Collaborative Doctoral Program in Global Health Guest lecturer on "The Challenges of Environmental Health in a Rapidly-Changing World, from the Molecular to the Global".
2014	JCR1000 "Interdisciplinary Approach to Global Challenges" Guest lecturer on "Global Environmental Health"
2014-	PHS100H1 "Grand Opportunities in Global Health"; Guest lecturer on "Urban

Environments"

2015 Public Health & Preventive Medicine Residency Rounds "Physicians, Climate, and other Global Environmental Changes: Our Role"

2016 CHL5004H Introduction to Public Health, Course Co-Director (with Professor Erica DiRuggierro)

2016 CHL 7001H F6 Environmental-Molecular Epidemiology, Course Co-Moderator (with Professor Morteza Bashash)

2016 CHL5701H Doctoral Seminar, Collaborative Doctoral Program in Global Health, Course Co-Director (with Professors Erica DiRuggierro and Abdallah Daar)

2016 Joint Seminar, "The Impact on Intelligence, Behaviour, and Society of Lead Exposure: A Case Study of a Global Pollutant and On-going Research"; Collaborative Program in Neurosciences and Collaborative Global Health Doctoral Program, University of Toronto

2016 CHL5420H "Global Health Research Methods"
Guest lecturer on "The Early Life Exposures in Mexico to Environmental Toxicants Project (ELEMENT): A Global Health Collaboration Case Study"

Masters student research advisor
Maelle Marchand

Doctoral student advisor
Adele Carty

Doctoral student thesis committee member
Laura Bogaert

Doctoral student thesis examination committee member
Claudie CY Wong (doctoral student in epidemiology, Jockey School of Public Health and Primary Care, Chinese University of Hong Kong)
Zilong Zhang (doctoral student in epidemiology, Jockey School of Public Health and Primary Care, Chinese University of Hong Kong)

Post-doctoral fellow mentor:
Siying Huang, Ph.D.; Morteza Bashash, Ph.D.; Roman Pabayo, Sc.D. (Harvard School of Public Health); Tripler Pell, M.D., M.P.H.

4. LOCAL CONTRIBUTIONS (at the University of Washington, 2017-2020)5

Doctoral student thesis research mentor
Megan Suter

Doctoral student special projects advisor
Rachel Shaffer
Joey Frostad
Rebecca De Buen

5. LOCAL CONTRIBUTIONS (at the University of Southern California, 2020-present)

2020- PM 502 Foundations of Public Health
Guest lecturer on "Global Health and the Global Burden of Disease Study"

2020- PM 601 Basic Theory and Strategies in Prevention
Guest lecturer on "Sociocultural Theories: Health Disparities and Environmental Justice"

2021- Health Justice and Systems of Care curriculum, Keck School of Medicine Year 01
Guest lecturer on "Introduction to Public Health (in a Hot, Crowded, Diverse, Aging, Inequitable, Urbanized, Polluted, Thirsty, Hungry, Debt-Ridden World)"

6. NIH K-grant mentorship:

Robert Wright, M.D., M.P.H. (K-23 ES000381, "*Neurochemical and Genetic Markers of Lead Toxicity"*), 2000-2005; Dr. Wright is now Prof of Pediatrics, Mt. Sinai School of Medicine
Marc Weisskopf, Ph.D. (K-01 ES012653, "*New Biomarkers of Neurotoxicity*"), 2004-2009; Dr. Weisskopf is now Associate Prof of Occup Health, Harvard Sch Public Health
Sung Kyun Park, Sc.D. (K-01 ES016587; "*Environment, Novel Aging Outcomes, and Genetics*"), 2009-2014; Dr. Park is now Assistant Prof, Department of Epidemiology, University of Michigan Sch Public Health
Emily Somers, Ph.D. (K-01 ES019909; *"Immune Dysfunction Associated with Early Life Heavy Metals Exposure"*), 2011-2016; Dr. Somers is now Associate Prof, Division of Rheumatology, Department of Internal Medicine, University of Michigan Medical School
Ashley Malin, Ph.D. (K-99 ES031676; "Childhood fluoride exposure and sleep patterns", 2021-2026; Dr. Malin is currently a fellow in the Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California

COMMITTEE, ORGANIZATIONAL, AND VOLUNTEER SERVICE

National/International

1978-1982 Taskforce on Occupational and Environmental Health, Co-coordinator, Am Med Stu Assoc
1989 Ad Hoc Study Committee, National Institute for Environmental Health Sciences Council
1989-2006 Association of Occupational and Environmental Medicine Clinics (AOEC)-- (through the Northeast Specialty Hospital Center for Occupational and Environmental Medicine)
1989-1990 Member, Relative Risk Reduction Strategies Committee, Science Advisory Board, U.S. Environmental Protection Agency
1989-1992 Member, Board of Directors, Physicians for Human Rights, Boston, MA

1991 National Institutes of Health, General Clinical Research Center Program, Site Visit Team
1992-2019 Member, National Advisory Committee, Physicians for Human Rights, Boston, MA
1992 Special Study Section member (R3/S1/B3), National Institutes of Health
1994 Ad Hoc Reviewer, National Institutes of Health, General Dental Research Center Program
1994 Advisory Board, Institute for Energy and Environmental Research
1994-1996 Associate, Project on Global Environmental Change and Health, Physicians for Social Responsibility
1995 Ad Hoc Reviewer, National Institutes of Health, Diagnostic Radiology Study Section
1996- Membor, Editorial Board, Health and Human Rights—an International Journal
1995-1998 Advisory Committee, Consortium for Environmental Education in Medicine, Cambridge, MA.
1996-1997 Reviewer, Agency for Toxic Substances and Disease Registry
1997-1998 Program Committee, Annual Mtg, NIEHS Superfund Basic Research Group Centers
1998-2013 (Founding) Medical Editor (1998-2004); Associated Medical Editor (2004-), Environmental Health Perspectives (official journal of NIEHS)
2001 Ad Hoc Reviewer, National Institutes of Health, R-13 applications
2002-2006 External Advisory Committee, Program Project on Lead and Osteoporosis, University of Rochester
2003-2005 Member, Ad-Hoc Expert Panel to Form Medical Management Guidelines for Lead-Exposed Adults, (supported by NIOSH and AOEC)
2003-2009 Member, Working Group on Lead and Pregnancy, Advisory Committee on Childhood Lead Poisoning Prevention, U.S. Centers for Disease Control and Prevention
2004 Ad Hoc Reviewer, National Institutes of Health, K-23 applications
2004 Ad Hoc Reviewer, Draft of "Immunization Safety Review: Vaccines and Autism" Immunization Safety Review Committee, Institute of Medicine, National Academies of Science
2004 Finalist (one of 8), Search for Director, National Institute for Environmental Health Sciences, U.S. National Institutes of Health
2005 Member, Strategic Planning Conference, National Institute for Environmental Health Sciences, Research Triangle Park, NC
2006 Ad Hoc Reviewer, Draft of "Preterm Birth: Causes, Consequence, and Prevention" Committee on Understanding Premature Birth and Assuring Health Outcomes, Institute of Medicine, National Academies of Science
2006 Member, External Advisory Committee, NIEHS Center, University of Rochester
2007 Member, Ad Hoc Study Section, Special Emphasis Panel/Scientific Review Group 2007/05 ZES1 JAB-C (DI) (NIEHS Discover Centers)
2007-2010 Member, Board on Population Health and Public Health Practice, Institute of Medicine, National Academies, Washington DC.
2007 Member, Ad Hoc Review Panel, Centers of Excellence Program, Swedish Council for Working Life and Social Research.
2007-2008 Member, Search Committee for Director of Extramural Research, NIEHS
2007 Special Consultant, Ad Hoc Study Section, Special Emphasis Panel/Scientific Review Group 2008/01 ZAR1 CHW-G (NIAMS Arthritis Centers)

2008	Report Reviewer, Draft National Research Council Report, "The National Children's Study Research Plan: A Review", National Academies
2008	Report Reviewer, Draft National Research Council Report, "Gulf War and Health: Updated Literature Review of Depleted Uranium", Institute of Medicine, National Academies
2008-2009	Data Safety Monitoring Board, "d-Penicillamine Chelation in lead-poisoned Children—A Phase II/III Trial" (R01FD003361; PI: Michael Shannon)
2008	Subcommittee to review Draft Report on Bisphenol A, Science Board, Food and Drug Administration
2008	Planning Committee, International Symposium on the Environmental and Health Consequences of Metal Mining and Smelting
2008-2009	Co-Chair, Planning Committee, "Climate Change Impacts on Public Health in India", Workshop that took place in Goa, India in Aug-Sept 2009 co-sponsored by UM Center for Global Health, the US Centers for Disease Control and Prevention and the Indian Council for Medical Research
2008	Finalist (one of 2), Search for Director, National Institute for Environmental Health Sciences, U.S. National Institutes of Health
2009-2012	Member, Board on Environmental Studies and Toxicology, National Research Council
2009	Reviewer, NIH Challenge Grants, Special Emphasis Panel/Scientific Review Group 2009/10 ZRG1 GGG-F
2009-2010	External Member, Academic Program Review Site Visit Committee, Department of Environmental and Occupational Health Sciences, University of Washington School of Public Health
2010-2012	Member, External Advisory Committee, University of Rochester NIEHS P30 Core Center
2010	Member, Ad-hoc review committee, National Health Research Institutes of Taiwan, Special Emphasis Panel—NHRI-Kaoshiung Medical College Program Project on ": "Gene Environment Interaction in the Genesis of Asthma and Allergic Diseases"
2010-2012	Member, Advisory Board, Institute of Public Health, Florida Agricultural & Mechanical University, Tallahassee, FL
2011	Reviewer, NIEHS Career Development Awards, Special Emphasis Panel/Scientific Review Group 2011/05 ZES1 LKB-J (K9)
2011-2016	Member, NIEHS National Advisory Environmental Health Sciences Council
2012	Member, Editorial Board, Journal of Alzheimer's Disease
2015	Member and External Reviewer, School of Population and Public Health Review Committee, University of British Columbia, Vancouver, B.C.
2016-2021	Chair, Board of Directors, Canadian Urban Environmental Health Research Consortium, (National Consortium based out of the Dalla Lana School of Public Health)
2017-	Member, Energy Research Committee, Health Effects Institute, Boston, MA
2017-2018	Executive Co-Chair, Workshop on the Global Burden of Disease-Pollution and Health Initiative, March 1-2, 2018, Institute for Health Metrics and Evaluation, Seattle, WA
2017-	Executive Co-Leader, Global Burden of Disease-Pollution and Health Initiative
2019-	Member, Research Advisory Committee, Centre of Environmental Health, The Public Health Foundation of India and the Tata Institute of Social Sciences, New Delhi, India

2019 Reviewer, draft report on trace metals levels in pregnancy women, Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention, Atlanta
2019 Reviewer, draft report on Concentration-Response Functions between Lead Exposure and Adverse Health Outcomes for Use in Benefits Analysis: Cardiovascular-Disease Related Mortality", EPA National Center for Environmental Economics Office of Policy
2019- Member, Advisory Council, Physicians for Human Rights, New York, NY
2019 Reviewer, Special Emphasis Panel/Scientific Review Group 2020/01 ZES1 LAT-S (K9) Applications, Center for Scientific Review, U.S. National Institutes of Health
2019-2020 Member, Board of Advisors Taskforce, Marilyn Brachman Hoffman Foundation, Dallas, TX
2020- Member, External Advisory Committee, New York University/NIEHS Environmental Health Core Sciences Center, New York, NY
2020 Member, NIEHS DR2 Work Group SARS-CoV-2/COVID-19 Environmental Health Research Needs Panel.
2020- Chair, Scientific Advisory Board, the Marilyn Brachman Hoffman Foundation, Dallas, TX
2020 Member, The Lancet Commission on Pollution and Health: Update
2022 Member, Review Panel, RFA-RM-21-025: NIH Faculty Institutional Recruitment for Sustainable Transformation (FIRST) Program: FIRST Cohort. Office of the NIH Director, Office of Strategic Coordination.
2022- Member, Board of Directors, Pure Earth, New York, NY.

Regional

1988-1990 Health Facilities Appeals Board, Member, Dept. Public Health, Comm. Of Mass.
1988-2006 Advisory Board, Massachusetts Department of Public Health, Sentinel Event Notification System for Occupational Risks (SENSOR) Project
1989-1995 Advisory Board, Massachusetts Division of Occupational Hygiene, Lead Registry Project
1990-1992 Board of Directors, Member, Health Care for All, Boston, Massachussetts
1993-1995 Faculty Council, Member, Harvard School of Public Health
1995-2006 Faculty Advisory Committee, Public Health Practice Program, Harvard School of Public Health
1996-2006 Advisory Board, Boston VA Environmental Hazards Center, Boston
1997-2001 Faculty Steering Committee, Center for Children's Health, Harvard School of Public Health
1996-2006 Senior Epidemiology Consultant, Massachusetts Veterans Epidemiology Research and Information Center, Boston.
1996-2006 Associate, Center for Health and the Global Environment, Harvard Medical School
1997-2002 Faculty Advisory Committee on Continuing Professional Education, Harvard School of Public Health
1998-2006 Faculty Steering Committee, Masters of Public Health program, Harvard School of Public Health
2001-2003 Board of Directors, New England College of Occupational and Environmental

Medicine
2001-2006 Associate Director, Harvard NIEHS Environmental Sciences Center, Harvard School of Public Health
2001-2006 Senior Advisory Council Member, Lowell Center for Sustainable Production, University of Massachusetts, Lowell, MA
2003-2006 Member, Human Subjects Committee, Harvard School of Public Health
2003-2006 Advisory Committee, Occupational Health Services Research Program, Harvard School of Public Health
2006 Study Section Review Committee, Pilot Project Program, Graham Environmental Sustainability Institute, School of Natural Resources and Environment, University of Michigan
2006-2007 Chair, Planning Committee, Health Sector, May 8-10, 2007 National Summit on Coping with Climate Change, University of Michigan
2007-2009 Member, Advisory Committee, SPH Practice Committee, University of Michigan School of Public Health
2007-2012 Member, Residency Advisory Committee, General Preventive Medicine Residency, University of Michigan School of Public Health
2008-2009 Member, Steering Committee, NIA T32 Training Grant on Aging Research (PI: Mary Haan), University of Michigan School of Public Health
2008-2013 Member, Advisory Committee, Outstanding New Environmental Scientist Awardee (Marie O'Neill), NIEHS
2008-2009 Member, Search Committee for Director of the Risk Science Center, University of Michigan School of Public Health
2009 Co-Chair, Planning Committee, Workshop on Predicting and Preventing Climate Change Impacts on Public Health, Goa, India (Collaboration with the UM Center for Global Health, the US Centers for Disease Control and Prevention, and the Indian Council for Medical Research)
2009-2011 Director and PI, NIA T32 Training Grant on Aging Research, University of Michigan School of Public Health
2009-2010 Member, Planning Committee, University Research Corridor (U of M, Michigan State, Wayne State) symposium on environmental health sciences in January 2010
2009-2012 Faculty Associate, Center for Global Health, University of Michigan
2009-2012 Member, Internal Advisory Board, Cancer Epidemiology Education in Special Populations Program, University of Michigan School of Public Health
2009-2011 Chair, Steering Committee on Global Health, University of Michigan School of Public Health
2010-2012 Member, Executive Committee, Graham Environmental Sustainability Institute, University Of Michigan
2010-2012 Member, Committee on Diversity, University of Michigan School of Public Health
2012-2017 Chair, Executive Committee, Dalla Lana School of Public Health, University of Toronto
2012-2017 Chair, Tenure Committee, Dalla Lana School of Public Health, University of Toronto
2012-2017 Chair, Decanal Promotions Committee, Dalla Lana School of Public Health, University of Toronto
2012-2017 Chair, Executive Advisory Committee, Institute for Global Health Equity & Innovation,

Dalla Lana School of Public Health, University of Toronto
2013-2015 Interim Director, Institute for Global Health Equity & Innovation, Dalla Lana School of Public Health, University of Toronto
2013-2014 Co-Chair, Research Committee, Dalla Lana School of Public Health, University of Toronto
2014-2017 Chair, Executive Advisory Committee, Institute for Health Policy Management and Evaluation, University of Toronto
2014 Chair, Ad-hoc Committee to create an Institute for Indigenous Health (based on a $10 million endowment gift made to DLSPH), Dalla Lana School of Public Health, University of Toronto; Chair, Executive Advisory Committee beginning 2015
2015-2017 Chair, Executive Advisory Committee, Joint Centre for Bioethics, University of Toronto
2015-2018 Chair (2015-2017); Member (2017-2018), Taskforce on Environmental Health, Ministry of Health and Longterm Care, Province of Ontario
2016-2017 Chair, Executive Advisory Committee, Centre for Critical Qualitative Health Research, University of Toronto
2017-2018 Executive Co-Chair, Workshop on the Global Burden of Disease-Pollution and Health Initiative (a collaboration between the Global Alliance on Health and Pollution and the Institute for Health Metrics), Seattle, WA
2020- Chair, Executive Committee, Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA
2020- Co-Leader, Population Health COVID-19 Pandemic Research Center, Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA
2020- Member, Public Health Advisory Committee, Office of the Provost, University of Southern California, Los Angeles, CA
2020- Member, Presidential Working Group on Sustainability, University of Southern California, Los Angeles, CA

Hospital

1982-1985 Occupational Safety and Health Committee, Member, Boston City Hospital, Boston
1983-1984 House Officers Association, Treasurer, Boston City Hospital
1984-1985 House Officers Association, Co-President, Boston City Hospital

OTHER PUBLIC SERVICE

1987 Member, Fact-finding tour on "The Health Effects of Massive Exposure to Tear Gas", Seoul, South Korea, July 11-18 (Sponsored by Physicians for Human Rights, American College of Physicians)
1988 Member, Fact-finding tour on "Chemical Weapons and the Iraqi Kurdish refugees", Turkey Oct 6-16 (Sponsored by Physician for Human Rights and the MacArthur Foundation)

1990 Leader, Fact-finding tour on "Health and Human Rights in Burma (Myanmar)", Thailand-Burma Dec. 26-Jan 6 (Sponsored by Physician for Human Rights and the MacArthur Foundation)
2009 Consultant and senior advisor, Fact-finding tour on “Mining and Potential Exposures and Health Effects in Guatemala”, August 2009 (Sponsored by Physicians for Human Rights)

CONSULTING POSITIONS

1987-1989 Consultant, "In-Vivo Total Body Lead Analysis by X-Ray Fluorescence", NIH/SBIR Grant 2R44ES03918-02
1988-1989 Consultant, "Boston Area Health Coalition Demonstration Project", DHHS/MP000003-A1
1993-1995 Consultant, Employee Health Services, Brigham and Women’s Hospital
1994 Consultant, Public Welfare Foundation, Washington, DC (review of Environmental Programs)
1997-2006 Consultant, Pediatric Environmental Health Center, Children’s Hospital, Boston, MA
2000 Consultant, Doris Duke Foundation, New York, NY (review of potential Environment and Medicine programs)
2009-2010 Consultant and Member, Academic Program Review Site Visit Committee, Department of Environmental and Occupationa Health Sciences, University of Washington School of Public Health, Seattle, WA
2011 Consultant, JPB Foundation, New York, NY (review of Environmental Health programs)
2014-2016 Advisor, Hearing Health Sciences, Ann Arbor MI and Amsterdam, Netherlands
2020 Consultant on Environment, Pollution and Health, United Nations Environment Programme, Nairobi, Kenya

VISITING PROFESSORSHIPS

1997 Alice Hamilton Visiting Professor, University of California at San Francisco
2000-2001 Visiting Professor, Sri Ramachandra Medical College & Research Institute, Chennai, India
2004 Visiting Professor, Department of Environmental Medicine, University of Rochester
2013 Visiting Professor, Shanghai Key Laboratory, Shanghai Jiao-Tung University

SEMINARS AND EXTRAMURAL INVITED PRESENTATIONS (last 15 years, since 2004; prior presentations upon request)

2004 Speaker, “New Frontiers in Understanding the Toxicity of Lead”, Department of Environmental Medicine, University of Rochester, Rochester, NY.
2003 Presenter, “Lead Exposure During Pregnancy: Mobilization of Maternal Bone Lead Stores and Their Threat to the Fetus”, Semi-annual meeting of the Childhood Lead Poisoning

Prevention Branch, Centers for Disease Control and Prevention, Baltimore, MD

2004 Presenter, "Environmental Medicine", Annual meeting of the Editorial Board, *Environmental Health Perspectives*, Baltimore MD

2003 Plenary speaker, "Metals, Genes, and Neurodegeneration: the Approach of the Metals Epidemiology Research Group at the Harvard School of Public Health", National Institute for Environmental Health Sciences Conference on Neurodegeneration.

2004 Discussant, "Suspected Lead Toxicity" Grand Rounds in Occupational/Environmental Medicine, Harvard School of Public Health

2004 Discussant, "Mercury Exposure in a Metal Worker", Grand Rounds in Occupational/Environmental Medicine, Harvard School of Public Health

2004 Presenter, "Effects of Our Environment on Intellect, Behavior, Life and Death," Leadership Council meeting, Harvard School of Public Health

2004 Guest Speaker, "Biomarkers, Genes, Interactions and Lead: New Insights from Research on an Old Hazard", Department of Environmental Health, University of Michigan School of Public Health

2004 Guest Speaker, "Medicine, Public Health, and the Great American Melting Pot: A Second-Generation Chinese-American Reflects on His Personal Odyssey", Sponsored by the Asian Student Association, Harvard School of Public Health

2004 Speaker, "Aging, the Environment and Genetics: Recent Insights from Epidemiologic Studies of Environmental Lead Exposure", Annual Leadership Retreat, National Institute for Environmental Health Sciences, Pinehurst, NC.

2004 Plenary Speaker, "Guidelines for the Management of Lead-Exposed Adults: Recommendations by a National Expert Panel Based on Recent Research", New England College of Occupational and Environmental Medicine Annual Meeting

2004 Lecturer, "Biomarkers, Genes, Interactions and Lead: New Insights from Research on an Old Hazard", Sri Ramachandra Medical College and Research Institute, Chennai, Tamil Nadu, India

2005 Lecturer, "Your Child's IQ, Behavior and Neuropathology: Genes or Environment?", the Harvard Club of Boston, Boston, MA

2005 Guest Speaker, "Metals, Neurodevelopment, and Neurodegeneration: The Work of the Metals Epidemiology Research Group at HSPH", Neurostatistics Working Group, Harvard School of Public Health, Boston, MA.

2005 Plenary Speaker, "Aging, the Environment and Genetics: Recent Insights from Epidemiologic Cohort Studies of Environmental Lead Exposure", NIEHS Symposium on Aging and the Environment, Duke University, Durham, NC.

2005 Plenary Speaker, "SPECT Imaging and Chemical Intolerance", NIEHS/NIAA symposium on "Chemical Intolerance and Addiction: a Shared Etiology?", Research Triangle Park, NC

2005 Workshop Presenter, "Social and Environmental Threats: the Unnecessary Epidemics", Harvard School of Public Health Leadership Council Annual Conference, Boston, MA

2005 Keynote Speaker, "Our Food, Our Water, Our Homes: Toxic Metals", The Boston Foundation, Boston, MA.

2006 Invited Speaker (invited by David Schwartz, NIEHS Director), "Goal IV: Improve and Expand Community-Linked Research", Roundtable on Environmental Health Sciences, Research, and Medicine; Institute of Medicine, National Academy of Sciences, Wash DC.

2006 Speaker, “The Future of Environmental Health Sciences at the University of Michigan”, Dean’s Advisory Board, University of Michigan School of Public Health, Ann Arbor, MI
2006 Keynote Speaker and Harriett Hardy Annual Lecturer, “The ‘E’ in Occupational/ Environmental Medicine: the Present and the Future”, New England College of Occupational Medicine Annual Meeting, New Bedford, MA
2007 Speaker, “The Future of Environmental Health Sciences at the University of Michigan”, Meetings of the UMSPH Alumni Council and the EHS Emeritus Faculty, Ann Arbor, MI
2007 Moderator and Speaker, “The Normative Aging Study: Health Effects of Lead”, Symposium on the Health Effects of Lead, 2007 Annual Meeting of the International Society for Environmental Epidemiology, Mexico City, Sept 8, 2007
2007 Guest Lecture, “Uncovering the Impact of the Environment on Disease: Big Opportunities for Physician-Scientists”, Medical Scientist Training Program, University of Michigan Medical School
2007 Guest Lecture, “Industrialization, Pollution and Public Health in India: Can India Survive Modernization?”, Osher Institute, Ann Arbor, MI
2007 Plenary Speaker, “Environmental Equity: Local and Global Challenges and the Balance Between Research and Advocacy”, Michigan’s Premier Public Health Conference, October 16, 2007, Dearborn, MI
2007 Board Member Lecture, "Metals, Genes, Health and Human Rights: from the Molecular to the Global", Fall Meeting of the Board of Population Health and Public Health Practice, Institute of Medicine, National Academies of Science, Washington DC, Dec 13, 2007.
2008 Speaker, "MDs as Leaders for Change in Environmentalism", 2008 Annual Regional Political Leadership Institute, American Medical Student Association, University of Michigan Medical School, February 16, 2008
2008 Speaker, Grand Rounds, “The Impact of Environmental Pollutants on Disease: New Insights and Implications for Research and Medical Practice” Department of Medicine, University of Michigan Health System.
2008 Guest Lecture, "Emerging Insights into the Pervasive Influence of Environment Toxicants on Reproductive Outcomes and Offspring Development: Lead as a Case Study", Reproductive Sciences Program, University of Michigan
2008 Panelist, "Environmental Health in China", Public Health Grand Rounds, Division of Health Practice, University of Michigan School of Public Health
2008 Keynote Speaker, "Human Health and the Role of Water", Symposium on Water, Health & The Environment, Graham Environmental Sustainability Institute, University of Michigan
2008 Guest Speaker, “Lead Exposure and Toxicity: New Insights Using Molecular Epidemiology” Wadswoth Laboratories and SUNY-Albany
2008 Speaker: “Impact of Climate Change on Human Health: Vulnerability” 5th AKKA World Kannada Conference, Chicago IL
2008 Speaker, “The ‘E’ in Occupational/Environmental Medicine: the Present and the Future”, Michigan Occupational/Environmental Medicine Annual Meeting, Mackinac Island, MI
2008 Speaker, “Impact of Climate Change on Human Health”, University of Michigan Chapter of the American Medical Student Association, Ann Arbor, MI
2008 Speaker, “Early Life Origins of Adult Chronic Disease: Environmental Health and Toxicology at a Crossroads” Michigan Chapter fo the Society for Toxicology, Ann Arbor,

MI

2009 Speaker, “Evidence for Lead as an Environmental Stressor of Alzheimer’s Disease and the Role of Epigenetics”, Symposium Panel, Annual Meeting of the Society for Toxicology, Baltimore, MD

2009 Keynote Speaker, “Lead, Late-Life and Early Life Effects, and the Emerging Field of Environmental Epigenetics: Looking Ahead”, Annual Meeting of the American College for the Advancement of Medicine, San Diego, CA

2009 Speaker, "Lead Toxicity and Mechanistically-Oriented Molecular Epidemiology: Targeting the Epigenetics of Alzheimer’s Disease", Seminar Series, Institute for Environmental Health Sciences, Wayne State University, Detroit, MI

2009 Speaker, “Climate Change Impacts on Health in the Developing World”, Research Discussion Series, University of Michigan Center for Global Health

2009 Speaker, “Autism, Aggressive Behavior, Anxiety, and Alzheimer's: are Environmental Toxicants Playing a Major Etiologic Role?”, Department of Psychology, University of Michigan

2009 Speaker, “Early Life Exposures and Endocrine Disruption: Evidence from Molecular Epidemiology”, Pediatric Endocrine Seminar, University of Michigan Medical School

2009 Distinguished Speaker, “Lead Toxicity: Twenty Years of Research On The Poison That Keeps on Poisoning” 10th Anniversary of the Department of Microbiology and Environmental Toxicology, University of California at Santa Cruz

2010 Speaker, “The Centers for Disease Control and Prevention & the Environmental Protection Agency: Potential Funding Opportunities for Regional Collaboration in Michigan”, University Research Corridor Symposium on Environmental Health, Detroit, MI.

2010 Speaker, “The Future of Public Health”, University of Washington School of Public Health

2010 Speaker, “The Environment Meets the Epigenome: Is This Where Autoimmunity Begins?” Symposium on Autoimmunity and Epigenetics, University of Michigan

2010 Keynote Speaker, “A New Twist to an Old Story: The Evidence for Early Life Lead Exposure as a Risk Factor for Alzheimer's Disease through Epigenetic Programming”, NIEHS Environmental Health Sciences Center and Toxicology Training Program Retreat, University of Rochester, NY

2010 Speaker, “Lead Toxicity: Twenty Years of Research on The Poison That Keeps on Poisoning” and “Environmental Health Sciences at the University of Michigan”, Tianjin Centers for Disease Control, Tianjin, China

2010 Speaker, “Pediatric Lead Toxicity”, Xinhua Hospital and the Shanghai Jiao-Tung Medical University Department of Pediatrics, Shanghai, China

2010 Speaker, “Environmental Health Sciences at the University of Michigan”, Fudan University, Shanghai, China

2010 Speaker, “Alzheimer’s Disease, Epigenetics and the Environment”, Symposium Update, Alzheimer’s Disease Association, Ann Arbor, MI

2010 Speaker, “Environmental Justice, Progress (and the Lack Thereof) and the Role of Research”, Roundtable on Environmental Health Sciences, Research and Medicine, Institute of Medicine, National Academies, Washington DC.

2010 Speaker, “White Coats, Population Science and Poison Gas: A Life Spent at the Intersection of Academic Medicine, Global Health & Human Rights”, Robert Wood Johnson Clinical

Fellows Program, University of Michigan Medical School, Ann Arbor, MI

2011 Speaker, "The Three Most Difficult Challenges to Molecular Epidemiologic Research on Gene-Environment Interactions: Lead Toxicity as a Case Study." Department of Human Genetics, University of Michigan Medical School, Ann Arbor, MI

2011 Speaker, "The Integration of Data on Environmental Carcinogens with Population and Genetic Resources", "Opportunities & Challenges for Translational Research on Cancer Prevention", Translational Cancer Prevention & Biomarkers Workshop, Mazamdur-Shaw Cancer Center, Bangalore, India.

2011 Speaker, "Success in the Academy", Faculty Panel, Students of Color of Rackham, Rackham Graduate School, University of Michigan

2011 Speaker, "White Coats, Population Science and Poison Gas: Fact-Finding Missions by Health Professionals for Human Rights" , Sujal Parikh Memorial Symposium, University of Michigan Medical School.

2011 Speaker, "The Analysis of Biomarker Data to Ascertain the Contribution of Environmental Exposures to the Etiology of Disease: Lead Exposure and Toxicity as a Case Study", Department of Computational Medicine and Bioinformatics, University of Michigan Medical School.

2012 Speaker, "Research and Analysis Linking Upstream and Downstream Disparities Work", Webinar hosted by the Health & Environmental Funders Network, Bethesda, MD, with 52 Foundations related Health.

2012 Keynote Speaker, "The Future of Public Health & Medicine in a Crowded, Diverse, Stratified, Hot, Urbanized, Polluted, Thirsty, Hungry and Debt-Ridden World". E.J. Van Liere Memorial Convocation and Health Sciences Center Research Day, West Virginia University, Morgantown, West Virginia

2012 Plenary Speaker, "Transgenerational Impacts of Pollutants on Offspring: Recent Insights and Case Studies", Connaught Global Challenge International Symposium, University of Toronto.

2012 Speaker, "Environmental Impacts on Aging (+ an update on the Dalla Lana School of Public Health)", Community Medicine Rounds, University of Toronto

2012 Speaker, "The Environment & Public Health in a Research-Intensive University: Opportunities for Scholarship in a Crowded, Diverse, Stratified, Hot, Urbanized, Polluted, Thirsty, Hungry and Debt-Ridden World", School for the Environment, University of Toronto

2012 Speaker, "Big Public Health Challenges (& Opportunities) in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World", External Advisory Meeting, Public Health Ontario, Toronto

2012 Speaker, "Canadian Public Health Schools (in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World): The View from Toronto, External Advisory Board Meeting, Institute for Population and Public Health, Canadian Institutes for Health Research, Toronto

2012 Speaker, "Sustainable Development and Health: The Global Mining Industry", Canadian Society for International Health Annual Meeting, Ottawa

2012 Speaker, "Big Public Health Challenges (& Opportunities) in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World", Xinhua

Hospital/Shanghai Jiao-Tung University, Shanghai, China.

2012 Speaker, "The Impact of Population-Wide Lead Exposure and Gene-Lead Interactions on Chronic Disease", Genetic Grand Rounds, Sick Kids Hospital, Toronto.

2012 Speaker, "Looking behind the curtain: Lead Toxicity as a Case Study of Methodologic Challenges in Gene-Environment Interactions Research", Strategic Training in Advanced Genetic Epidemiology (STAGE), Dalla Lana School of Public Health, University of Toronto.

2012 Keynote speaker: "Public Health—the Next Frontier in Health Professions Education". Council of Health Sciences annual retreat, University of Toronto.

2013 Speaker, "White Coats, Population Science and Poison Gas: Lessons from a Life Spent at the Intersection of Academic Medicine, Global Health & Human Rights", Joint Center for Bioethics, University of Toronto

2013 Speaker, "Gauging environmental impact on the development of chronic inflammation", Connaught Global Challenge Workshop, University of Toronto.

2013 Speaker, "The Future of Public Health & Medicine in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World", Grand Rounds, Department of Medicine, University of Toronto.

2013 Speaker, "Metals, Mega-trends, and Me: Reflections on Research and the Vision for the Dalla Lana SPH", Occupational and Environmental Medicine Grand Rounds, St. Michael's Hospital, Toronto, ON.

2013 Speaker, "Air pollution and Cardiovascular Disease: Health Impacts, Mechanisms, and Research Opportunities", UniversityofToronto & FMUSP-InCor SymposiumonCardiology, Sao Paolo, Brazil.

2013 Speaker: "Lead Exposure's Impact on Health and Policy: A History of Neglect and Missed Opportunities", Public Health Policy Rounds, CIHR Strategic Training Program in Public Health Policy, University of Toronto.

2013 Speaker: "Lead Toxicity: The Long Tail of Health Impacts (and On-going Research Opportunities!) From an Historical Environmental Air Pollutant", Southern Ontario Centre for Air Pollution and Aerosol Research, University of Toronto.

2013 Speaker: "Water and Sanitation", Water, Sanitation and Hygiene (WASH) Canada, Toronto, Ontario, Canada

2014 Speaker: "Conflict and Public Health", Ontario Medical Association, Toronto, Canada

2014 Panelist: "Judging Evidence: Finding a Place for Variation in an Evidence-Based World", Health Quality Ontario, Toronto, Canada

2014 Speaker: "The Grand Convergence: Creating Health in a Globalized World", Special meeting of the Canadian Chamber of Commerce in Shanghai

2014 Speaker: "The Grand Convergence: Creating Health in a Globalized World", Jockey School of Public Health and Primary Care, Chinese University of Hong Kong, Hong Kong, China

2015 Speaker: "The Grand Convergence: Creating Health in a Globalized World", School of Public Health and the ASEAN Institute, Mahidol University, Bangkok, Thailand

2015 Speaker: "Gene-environment Interactions and the Role of Big Data in Environmental Health" Seminar series, School of the Environment, University of Toronto, Toronto, Canada

2015 Speaker: "Global Health Security", Ill with Illness—Economic, Social & Security Barriers to the Provision of Global Health, Munk School of Global Affairs, University of Toronto, Toronto, Canada

2015 Speaker: "The Dalla Lana School of Public Health: Big Ideas and Initiatives for Creating Health in a Globalized World", Speaker Series, University of Toronto Alumni of Toronto.
2015 Speaker: "Unique Scientific Opportunities for the Precision Medicine Initiative National Research Cohort: Exposomics, Data Linkage, and Global Collaborations". Working group on President Obama's Precision Medicine Initiative (Chaired by Francis Collins, Director, NIH)
2015 Speaker: "What is the Role of Schools of Public Health in the 21st Century?" 50th Anniversary Celebration of the Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, Quebec.
2015 Welcoming Address: "Global Public Health and Mental Health", Going Glo-cal for Mental Health conference, Centre for Addictions and Mental Health/Department of Psychiatry/Dalla Lana School of Public Health, Toronto, ON
2015 John Goldsmith Memorial Lecture: "Big Data, Environmental (and Social) Epidemiology, Power and Politics", Opening Plenary Session, International Society for Environmental Epidemiology Annual Meeting, Sao Paulo, Brazil
2015 Inaugural Speaker: "The Future of Public Health and Medicine in a Crowded and Complex World", Global Health Leadership Series, PSG Medical School & the Shanti Ashram Foundation, Coimbature, Tamil Nadu, India
2016 Speaker "The Future of Public Health & Medicine in a Crowded, Diverse, Aging, Stratified, Urbanized, Polluted, Hot, Thirsty, Hungry, Debt-Ridden World", Indian Institutes of Public Health—Hyderabad, Hyderabad, India
2016 Speaker: "Integration of Public Health & Health Care: The Unmet Agenda for a Truly Sustainable Health System", Board of Directors Retreat, Toronto East General Hospital, Toronto
2016 Plenary speaker: "Health Promotion, Prevention and Health Protection: Innovative Initiatives", 6th Asia-Pacific Conference on Public Health | 1st ASEAN Health Promotion Conference Bangkok, August
2016 Speaker: "Big Data, Environmental (and Social) Epidemiology, Power and Politics", Mount Sinai School of Medicine, New York, NY
2016 Plenary Speaker: "The Impact of Environmental Toxicants on Health: Recent Epidemiologic Approaches & Advances", International College of Integrative Medicine Annual Meeting, Toronto, ON
2016 Plenary Speaker: "Big Data and Implications for Environmental Health", 15th Anniversary Conference, Jockey Club School of Public Health & Primary Care, Chinese University of Hong Kong, Hong Kong
2016 Plenary Speaker: "Innovations in Assessing Lead Poisoning and Child Health: Policy & Clinical Implications", Chinese University of Hong Kong-Fudan-Oxford International Symposium on Health Impacts of Environmental Exposures", Hong Kong
2016 Speaker: "Addressing a Changing Environment (and Impacts on Health, AKA Can India Survive Modernization?", Indian Institutes of Technology Alumni, Canada, International Conference 2016, Toronto.
2016 Plenary Speaker, "Hidradenitis Suppurativa: Research Directions from a Population Health Perspective", Symposium on Hidradenitis Suppurativa Advances, Toronto.
2016 Plenary Speaker, "Children's Environmental Health", The 2016 Annual National Conference on Children's Healthcare, Shanghai, China

2016 Special Guest Speaker, "Big Data, Environmental (and Social) Epidemiology, Power and Politics", Shanghai Municipal Center for Disease Control, Shanghai, China
2016 Lecturer, "Lead and Human Health: Recent Research and Associated Lessons for Science & Policy", Fudan University School of Public Health, Shanghai, China
2017 Lecturer, "The Impact of Environmental Toxicants on Health: Recent Epidemiologic Approaches & Advances", Saw Swee Hock School of Public Health, National University of Singapore, Singapore
2017 Lecturer, "The Future of Academic Public Health", Saw Swee Hock School of Public Health, National University of Singapore, Singapore
2017 Lecturer, "Recent Advances in Understanding, Preventing, and Reversing the Impact of Environmental Factors on Health", Society of Chinese Bioscientists in America, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, ON
2017 Lecturer, "Environmental Epidemiology in the Era of Exposomics, Lifecourse Epidemiology, Big Data and Big Science", Department of Environmental Health, Harvard School of Public Health, Boston, MA
2017 Speaker, "The Role of a Re-emergent Canadian School of Public Health in a Hot, Hungry, Polluted, Aging, Polarized World Prone to Pandemics, Chronic Disease, and Unsustainable Health Systems", Royal Canadian Institute for Science, Toronto, ON
2017 Speaker, "The Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) Birth Cohort Study: Current Research on Fluoride and Neurodevelopment", Seminar Series in Environmental Epidemiology, University of Washington School of Public Health, Seattle, WA
2017 Plenary Speaker: "New realities arising from the extractive industries and agri-business: the Pollution and health perspective," Hong Kong Summit of Global Health Leaders. University of Hong Kong, Hong Kong
2018 Plenary Speaker: "The GBD-Pollution and Health Initiative: Challenges & Opportunities", Workshop on the Global Burden of Disease-Pollution and Health Initiative, Institute for Health Metrics, University of Washington, Seattle, WA
2018 Guest Lecturer: "Partnerships, Local Responsiveness, National and Global Impacts", University of Iowa College of Public Health, Iowa City, IA
2018 Plenary Speaker: "Current Research on Fluoride and Neurodevelopment: The Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) Birth Cohort Study", Annual meeting of the International Academy of Oral Medicine and Toxicology, Denver, CO
2018 Speaker, "Recent Epidemiologic Research on Lead Toxicity: New Surprises regarding an Old Global Pollutant", Department of Environmental and Occupational Health Sciences Seminar Series, University of Washington School of Public Health, Seattle, WA
2018 Speaker: "The Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) Birth Cohort Study: Current Research on Fluoride and Neurodevelopment", Symposium on Fluoride research, Annual meeting of the International Society for Environmental Epidemiology/International Society for Exposure Science, Ottawa, ON
2018 Panelist, "The Fluoridation Decision: Considering the Evidence for Benefits, Possible Risks as well as Ethical World Views", Annual meeting of the International Society for Environmental Epidemiology/International Society for Exposure Science, Ottawa, ON
2018 Invited speaker: "Grand Opportunities", The UC-Irvine School of Population Health and the

Samueli College of Health Sciences, Irvine, CA

2018 Invited speaker, "The Global Burden of Disease-Pollution and Health Initiative", Office of The Director and the Global Environmental Health Program, U.S. National Institute for Environmental Health Sciences, Research Triangle Park, NC

2019 Invited speaker, "Evaluating, treating and managing disabilities of patients with chemical intolerance", Symposium on Chemical Intolerance—A Way Forward, Marilyn Brachman Hoffman Foundation and the Hoffman Program on Chemicals and Health at the Harvard T.H. Chan School of Public Health, Dallas, TX

2019 Invited Lecturer: "The Global Burden of Disease-Pollution and Health Initiative", Center for Population Health Sciences, Stanford University, Palo Alto, CA

2019 Invited Lecturer: "Lead and Fluoride: Old and New Toxicant Issues and the Global Burden of Disease", British Columbia Centre for Disease Control, Vancouver, BC, Canada

2019 Invited Lecturer: "Lead and Fluoride: Old and New Toxicant Issues and the Global Burden of Disease", University of California, Davis, CA, USA

2019 Invited speaker, "A Framework for Adding Environmental Exposure-Outcome Pairs to the Global Burden of Disease: The Global Burden of Disease-Pollution and Health Initiative", 2019 Annual Meeting of the International Society for Environmental Epidemiology, Utrecht, Netherlands

2019 Invited speaker, "The Global Burden of Disease – Pollution and Health Initiative: Impacts on Human Capital", Air Pollution, Health and Human Capital Nexus in Chinese Cities Scoping Meeting, Institute of Urban Environments, Chinese Academy of Sciences, Xiamen, China

2019 Invited Speaker, "Toxic Chemicals, Human Health, and Human Rights", A Human Right to Health: Pathways and Responses, Seattle University Law School, Seattle, WA

2020 Invited Lecturer: "The Herbert Wertheim School of Public Health at UC San Diego: Grand Opportunities." Universitiy of California at San Diego, San Diego, CA

2020 Invited speaker and panelist, "Health Effects, Historical and Contemporary Use of Tear Gas and Other Riot Control Agents", Environmental Exposure Grand Rounds, Minnesota Department of Health, Health Partners, University of Minnesota School of Public Health, Hennepin Regional Poison Center. (Webinar)

2020 Plenary symposium speaker: "The Pollution, Climate and Global Burden of Disease Initiative: The Challenge of Estimating Exposures in Countries with Little or No Data", Annual meeting (virtual) of the International Society for Exposure Science

2020 Invited Speaker, "The Pollution, Climate and Global Burden of Disease Initiative", the Centre for Air Pollution, Energy and Health Research (CAR), University of Sydney, Australia (Webinar)

2020 Invited speaker, "The ELEMENT birth cohort study, and the Global Burden of Disease-Pollution, Climate and Health Initiative: Two Opportunities for New Collaborations", The NIEHS P30 Southern California Environmental Health Sciences Center, University of Southern California (Webinar)

2020 Presenter, "Sustainability and Population Health: Ideas for an Agenda at USC, Presidential Working Group on Sustainability, University of Southern California

2020 Invited speaker, "The Global Burden of Disease—Pollution, Climate and Health Initiative: A Focus on the Potential Role of Spatial Sciences", the Spatial Sciences Institute, University

of Southern California

2020 Invited speaker, "Environment Exposures, Epigenetics, Epidemiology, Etiology, and Cancer: Which "E" is the Weak Link?" Norris Comprehensive Cancer Center, University of Southern California.

2021 Presenter, "Update on the Department of Preventive Medicine", Basic Science and Clinical Chairs Council, Keck School of Medicine, University of Southern California

2021 Invited Speaker, "The changing nature of population health management: The Population Health Perspective", Annual State of Reform Southern California Health Policy Conference, San Diego, CA

2021 Invited Speaker, "Update and Work on COVID-19, Health Inequities, and Social Justice", the 31st meeting of the California Public Health/Prevention Medical Leadership Forum.

2021 Invited Speaker, "The Department of Population and Public Health Sciences: Update and Our Work on Fast- and Slow-Moving Population Health Crises". Keck School of Medicine's 2021 Alumni Day CME program.

2022 Invited Speaker, "Lead Exposure and Non-communicable Diseases", The Impact of Lead Pollution on NCDs Webinar, co-sponsored by the Global Alliance on Health and Pollution, and the World Federation of Public Health Associations.

2022 Invited Speaker, "Environmental Risk Factors for Diabetes an Obesity: Endocrine-Disrupting Chemicals and the Built Environment", USC Diabetes and Obesity Research Institute's 9th Annual Research Symposium, Los Angeles, CA.

2022 Invited Speaker, "Long-lived Endocrine Disrupting Chemicals: Update on the Epidemiology", California Coastal Chloro-Contamination Conference. UC Santa Barbara, Santa Barbara, CA

2022 Invited Speaker, "The Lancet Commission on Pollution and Health: Progress Update", New York University School of Global Public Health, virtual briefing hosted by the Global Alliance on Health and Pollution

2022 Invited Speaker, "Hot Spots of Toxic Pollution in Kenya, Senegal and Tanzania (2016-2020): Data from the Toxic Sites Identification Program conducted by Pure Earth. International Society for Environmental Epidemiology Africa regional meeting (virtual).

INVENTIONS/PATENTS: n/a

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Peer-reviewed journals

1. Hu H, Markowitz SB. A case-study of industrial bladder cancer. Einstein Quarterly Review of Biology and Medicine 1982;1:29-35.

2. Hu H. Benzene and myelofibrosis. Annals of Internal Medicine 1987;106:171-172

3. Hu H, Milder FL, Burger DE. X-Ray Fluorescence: Issues surrounding the application of a new tool for measuring burden of lead. Environmental Research 1989;49:295-317.

4. Hu H, Fine J, Epstein P, Kelsey K, Reynolds P, Walker B. Tear Gas: Harrassing agent or toxic chemical weapon? JAMA 1989;262:660-663.

5. Hu H, Cook-Deegan R, Shukri A. The use of chemical weapons: Conducting an investigation using survey epidemiology. JAMA 1989;262:640-643.

6. Hu H, Tosteson T, Aufderheide AC, Wittmers L, Burger DE, Milder FL, Schidlovsky G, Jones KW. Distribution of lead in human bone: I. Atomic absorption measurements. Basic Life Sci 1990;55:267-274.

7. Burger DE, Milder FL, Morsillo PR, Adams BB, Hu H. Automated bone lead analysis by k-x-ray fluorescence for the clinical environment. Basic Life Sci 1990;55:287-292.

8. Schidlovsky G, Jones KW, Burger DE, Milder FL, Hu H. Distribution of lead in human bone: II. Proton microprobe measurements. Basic Life Sci 1990;55:275-280.

9. Jones KW, Schidlovsky G, Burger DE, Milder FL, Hu H. Distribution of lead in human bone: III. Synchrotron x-ray microscope measurements. Basic Life Sci 1990;55:281-286.

10. Hu H, Milder FL, Burger DE. X-ray fluorescence measurements of lead burden in subjects with low-level community lead exposure. Arch Environ Health 1990;45:335-341.

11. Hu H, Win KU, W, Arnison ND. Burma: Health and human rights. Lancet 1991;337:1335.

12. Hu H. A 50-year follow-up of childhood plumbism. Hypertension, renal function, and hemoglobin levels among survivors. Am J Dis Child. 1991 Jun;145(6):681-7. doi: 10.1001/archpedi.1991.02160060099029. PMID: 2035497.

13. Hu H. Knowledge of diagnosis and reproductive history among survivors of childhood plumbism. Am J Publ Health 1991;81:1070-1072.

14. Hu H, Milder FL, Burger DE. The use of K-X-Ray Fluorescence for measuring lead burden in epidemiological studies: high and low lead burdens and measurement uncertainty. Environ Health Perspect 1991;94:107-110.

15. Hu H, Pepper L, Goldman R. Effect of repeated occupational exposure to lead, cessation of exposure, and chelation on levels of lead in bone. Am J Ind Med 1991;20:723-735.

16. Hu H. Toxic weapons, epidemiology, and human rights. Polit Politics and Life Sci 1992;February:3-4.

17. Hu H, Sparrow D, Weiss S. Association of serum albumin with blood pressure in the Normative Aging Study. Am J Epidemiol 1992;136:1465-1473.

18. Hu H, Christiani D. Reactive airways dysfunction after exposure to tear gas. Lancet 1992;339:1535.

19. Hu H. Physicians, IPPNW, and the Environment. PSR Quarterly 1993;3:79-87.

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21. Hu H, Beckett L, Kelsey K, Christiani D. The left-sided predominance of asbestos-related pleural disease. Am Rev Resp Dis 1993;148:981-984.

22. Payton M, Hu H, Sparrow D, Young JB, Landsberg L, Weiss ST. Relation between blood lead and urinary biogenic amines in community-exposed men. Am J Epidemiol 1993;138:815-825.

23. Hu H, Kotha S. Ethics and epidemiology: International Guidelines. Polit Life Sci 1993;February:29-30.

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cancers: a preliminary report. Environ Geochem Health 1994;s16:119-128.

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Abstracts of Work (Upon request)

EXHIBIT 2

Howard Hu, M.D., M.P.H., Sc.D.
Consultant in Occupational and Environmental Medicine & Epidemiology[1]
Depositions, Trials, in US federal or state court cases, the last 4 years (2018-present, as of October 11, 2022)

DESCRIPTION: In each of these cases, Dr. Hu served as either a consultant in occupational and environmental medicine & epidemiology who evaluated a particular individual or individuals and rendered an expert opinion on general causation and/or specific causation, and/or as a consultant in occupational and environmental medicine & epidemiology who reviewed the literature on a particular issue and rendered a scientific opinion on general causation.

DATE	TYPE	CASE	CLIENT
5/16/19	Deposition	A.O.A., et al. v. Doe Run Resources Corporation, et al., Case No. 4:11-CV-00044-CDP	Schlichter, Bogard & Denton, LLP, St. Louis, MO
9/16/19-9/17/19	Deposition	Don Strong et al., v. Republic Services, Inc., et al.	Humphrey, Farrington & McClain, P.C., Independence, MO
9/24/19	Deposition	Food & Water Watch, Inc., et al, v. United States Environmental Protection Agency (US EPA), et al.	Non-retained expert, testifying on the work and results of my epidemiologic research team on the potential neurodevelopmental impacts of fluoride, in response to subpoena from the U.S. EPA., arranged by Waters Kraus Paul, P.C., Segundo, CA
10/9/19	Deposition	Pamela Butler, et al. v. Mallinckrodt, Inc., et al.	Humphrey, Farrington & McClain, P.C., Independence, MO
2/8/20	Trial	USA v. Gary Spengler, M.D.	Oberheiden & McMurrey, Dallas, TX 75240
6/8/20	Trial	Food and Water Watch v US EPA	(fact witness for the court)
8/6/20	Deposition	A.O.A. et al. v. Doe Run Resources Corp.	Schlichter, Bogard & Denton, LLP
8/31/20 and 9/1/20	Deposition	Marc Czapla and Jill Czapla v. Republic Services, Inc et al.	Humphrey, Farrington & McClain, P.C., Independence, MO
10/12/20 and 11/5/20	Deposition	Flint Water Cases, Civil Action No. 5:16-cv-10444-JEL- MKM	Weitz & Luxenberg P.C. 220 Lake Drive East, Suite 210 Cherry Hill, NJ
6/8/22 and 6/9/22	Deposition	Teresa Fornek v. Sterigenics, LLC et al.	Smith LaCien, LLP, Chicago, IL

[1] Current academic position, as of July 1, 2020: Professor and the Flora L. Thornton Chair of the Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California, Los Angeles, CA.

7/1/22	Deposition	Susan Kamuda v. Sterigenics, LLC et al.	Salvi, Schostok & Pritchard P.C., Chicago, IL
7/21/22	Deposition	Heather Schumacher v. Sterigenics LLC et al.	Romanucci & Blandin, LLC, Chicago IL
9/9/22	Deposition	Teresa Fornek v. Sterigenics LLC, et al.	Smith LaCien, LLP, Chicago, IL

EXHIBIT 3

Howard Hu, M.D., M.P.H., Sc.D.
Occupational/Environmental Medicine, Internal Medicine, and Epidemiology
*Flora L. Thornton Department Chair and Professor**
Department of Population and Public Health Sciences
Keck School of Medicine, University of Southern California

Consultant Address: 3363 Monterosa Drive, Altadena CA, 91001, USA
Consultant Email: howardhu2225@gmail.com

Consulting rates, as of July 2021

Pre-deposition and pre-trial work (reviewing documents, analyzing data, preparing reports, communications, etc.)

$600 US/hr

Deposition testimony

$1,000 US/hr

Trial testimony (at relevant location)

$8,000 US/day + travel expenses

Travel: $200 US/hr (door to door)

NOTE: Payments to be submitted as checks by mail or wire transfers to a U.S. bank account

* For identification and affiliation purposes only.

EXHIBIT 4

Summary List of All References in Hu Declaration

1. The question posed by Issue #6 relates to a "Multi-Defendant Issues Class" (defined as persons who, for any period of time between February 10, 2015 and October 16, 2015, were exposed to or purchased drinking water supplied by the City of Flint), and to a "LAN Issues Subclass" (defined as persons who, for any period of time between April 25, 2014 and October 16, 2015, were exposed to or purchased drinking water supplied by the City of Flint)."

2. Although the Class Period begins on April 25, 2014, I assume that the elevated levels of lead in water attributable to the water source switch to the Flint River do not begin until May 1, 2014. This issue is addressed in greater detail in the Declaration of Dr. Weisel.

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